

**JUNE 26, 1961**

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# *Chemical Engineering*

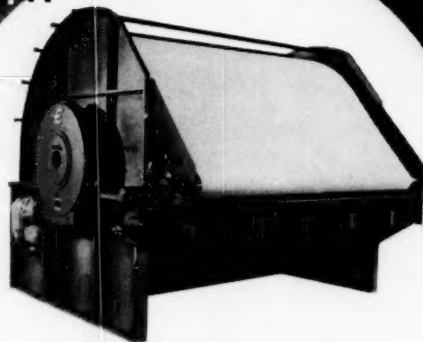
A MCGRAW-HILL PUBLICATION



**THE ROLE OF ELECTROSTATICS IN  
DUST FILTRATION**

COMPLETE CONTENTS, PAGE 3

In Over 100 Processing Operations ...



**EIMCOBELT® FILTERS**

## "On Stream" Continuously

EimcoBelt continuous vacuum belt filters have proved capable of staying "on stream" continuously, with no production slowdown caused by progressive blinding of filter media.

Even slurries of low solids concentrations, or slurries having pronounced blinding tendencies or poor cake discharge characteristics are being handled continuously on EimcoBelt filters.

This great forward step in filtration is possible because the EimcoBelt filter suc-

cessfully removes the belt filter medium from the drum every filter revolution for cake discharge and cloth washing. The medium is scoured clean with high velocity wash sprays, front and back, before being returned to the drum. Blinding is eliminated.

Ask the Eimco representative in your area to help you estimate the savings in your operations with EimcoBelt filters. Write Eimco Filter Division for Bulletin FE-2053.

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"Advanced Engineering and Quality Craftsmanship Since 1894"



B-686

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## Koroseal breathes corrosive fumes without killing itself

**Koroseal PVC won't corrode,  
can't rust or rot, is easy  
to fabricate and install**

**T**HAT 80-foot exhaust stack, being jockeyed into place, will carry away corrosive fumes from an automatic plater. Made of Koroseal rigid PVC, by B.F. Goodrich, it's expected to last at least 15 years. Pretty good service compared to the 3 or 4 years averaged by those corrosion-prone sheet metal stacks along side it.

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Though the initial cost of a Koroseal stack is higher than sheet metal, Koroseal actually saves money when you consider it lasts several times longer, costs less to install, and virtually eliminates maintenance and shutdowns.

For the full story on Koroseal's many advantages get in touch with a B.F. Goodrich distributor, or send for our catalog. *B.F. Goodrich Industrial Products Co., Dept. M-118, Akron 18, Ohio.*

Koroseal—T.M. Reg. U.S. Pat. Off.

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**KOROSEAL RIGID  
PVC PRODUCTS**

## PROFIT in PIGMENTS

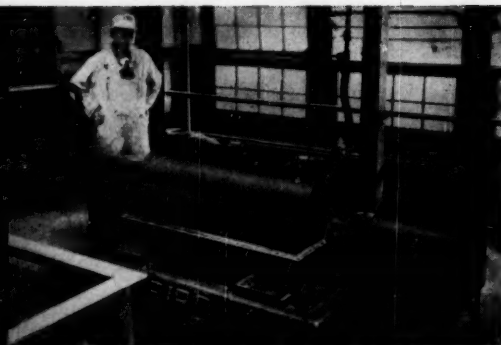
*depends on the*

## PRECISE PARTICLE SIZE

*that is obtained by*

# BIRD

*Continuous*  
**CENTRIFUGAL  
CLASSIFICATION**



Take *titanium oxide*, for example. This widely used, quality pigment must meet rigid particle size specifications. That is why, almost without exception, titanium producers throughout the world employ Bird Centrifugal Classifiers.

The same goes for producers of all other pigments and fillers that must conform to close particle size specifications, particularly in the minus 10 micron range.

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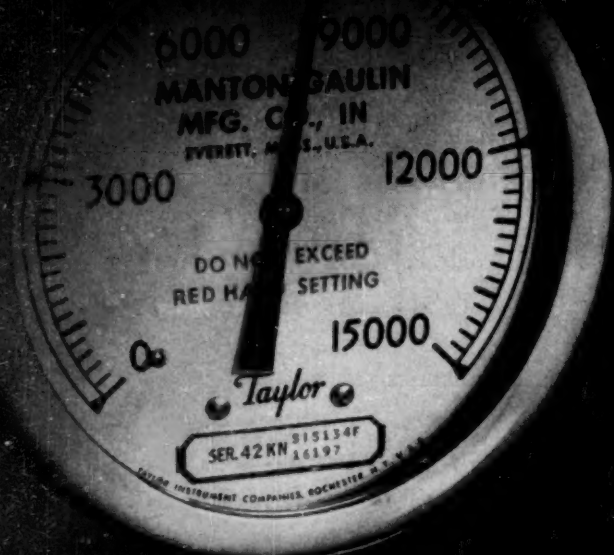
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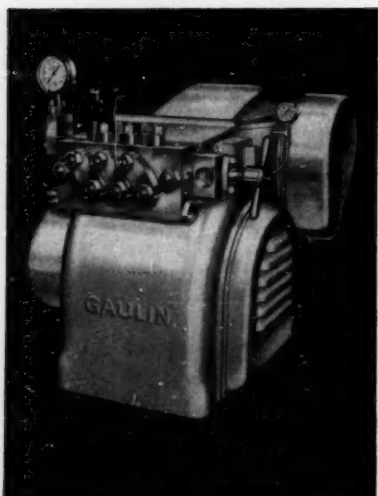
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quiver



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## ***Chemical Engineering***

JUNE 26, 1961

### *highlights of this issue*

#### **STEREO PLANT IS GRAFTED ONTO SBR LINE**

*Cis*-polybutadiene, the new stereospecific rubber, will soon be coming off the line at Goodrich-Gulf's plant at Institute, W. Va. Conversion of existing SBR facilities to production of the new elastomer is saving scads of time, as well as money, over the alternative of building a new unit from scratch. Credit for this story (p. 60) goes to Art Zimmerman, our McGraw-Hill News man in Cleveland.

#### **ZETA POTENTIAL: NEW PROCESSING TOOL**

Have you forgotten all you knew about colloidal chemistry? First of two installments, this article (p. 121) shows how zeta potential, a measurement of electrokinetic charge, can provide the key to improved agglomeration or dispersion of colloidal particles in water. Author Thomas Riddick writes from 25 years' consulting experience in water and waste treatment problems.

#### **ELECTROSTATICS IN DUST FILTER SELECTION**

While we're on the subject of colloids, here's another article showing how charged particles behave. This one (p. 107) deals with dry particles, and its practical application is in the field of dust filtration. It presents the findings of several years of study at Mellon Institute, and is written by E. R. Frederick, senior fellow at Mellon.

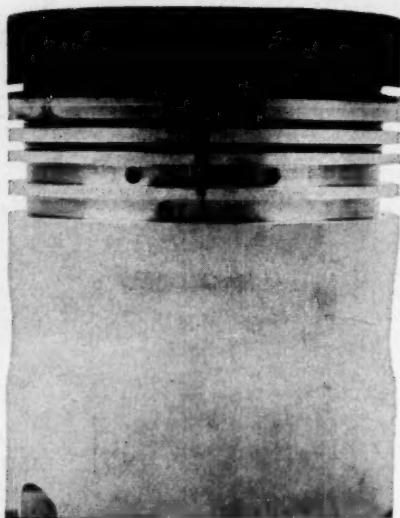
#### **PROFESSIONALISM IS A TWO-MILE ROAD**

Bill Cunningham, chemical engineering professor at University of Texas, echoes the theme of W. E. Wickenden's classic paper on "The Second Mile" in this You & Your Job feature (p. 136). Even if you don't agree with all Prof. Cunningham says about the attributes and responsibilities of professionals, this article will stretch your mind and broaden your outlook.



# NEW PARANOX<sup>®</sup> 221

*An improved detergent inhibitor  
designed for Series 3 lubricants*



Test piston from Caterpillar 1-G supercharged diesel engine after 480 hours operation with Series 3 lubricant. Clean ring zone emphasizes excellent detergent-inhibition properties of new Paranox 221.

Paranox 221, a new detergent-inhibitor package, is a potent additive for formulating Series 3 Oils. These lubricants are required to meet the severe lubrication needs of all engines found in heavy duty diesel equipment. Oils formulated with only 11-12 volume % of Paranox 221 will meet these demanding requirements.

The outstanding property of Paranox 221 is its excellent detergent inhibition action in base oils, demon-

strated by high piston cleanliness in Caterpillar 1-D and 1-G (shown above) supercharged engine tests. It also imparts long-term oxidation stability, rust protection and antifoam properties to finished lubricants. Because of these properties, a Series 3 lubricant formulated with Paranox 221 can be effectively used in various other applications where the equipment manufacturer recommends Series 3 oil, such as transmissions and final drives.

For a comprehensive new bulletin on Paranox 221, write to Enjay at 15 West 51st Street, New York 19, New York.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

**ENJAY CHEMICAL COMPANY**

A DIVISION OF HUMBLE OIL & REFINING COMPANY



### Little Finger, Working Hand

Sir:

I read with interest the You & Your Job article in your Apr. 3 issue (pp. 161-2) with regard to symbols for engineers.

Engineers in Canada have a most definite symbol. Every graduate of a Canadian university who has earned a degree in engineering wears an iron ring on the little finger of his working hand. Consequently it is relatively easy to recognize a Canadian engineer.

GERALD MCGURHILL

Montreal, Quebec

► *Jim Marshall, an assistant editor on our staff, proudly wears such a ring; he is a chemical engineering graduate of Queen's University, Kingston, Ont.—Ed.*

### Con: Third-Grade Arithmetic

Sir:

Your Plant Notebook is generally full of good ideas. Thus I was badly surprised to find the item in your Feb. 20 issue (p. 172) titled "Simple Method Proves Multiplication."

I was taught this simple method when I was in the third degree of primary school. I do not understand how you found a place for it in a technical magazine for engineers.

H. LAPIDOT

Tel Aviv, Israel

### Pro Trade, Con Aid

Sir:

About nine years ago, you carried an excellent editorial captioned "Aid or Trade? A Crisis Ahead."

As we are now in that crisis, we propose a plan which will give us our full share of trade, at an economic advantage to us.

Our plan will solve the unemployment problem. It will solve the farm surplus problem, and in addition will protect our gold-based dollar from devaluation.

All this will come to us through "assured trade," provided we establish a free American market for the world by removing all present tar-

iffs. Let the foreigner ship to us whatever he finds orders for, but let it be provided that the foreigner be paid for his exports, either by barter arrangement or through the use of an "international dollar" issued by our government, redeemable only in American goods or services, not in gold.

For instance, if a Japanese producer sends to us a pair of shoes which, with cheap labor, costs him \$5 to manufacture, he can be paid only if he accepts some American product made by our higher-paid workers. This will give us an economic advantage which will exist as long as those we trade with are lower-wage-standard nations.

Foreign aid (which we oppose) should be given, if given at all, only through use of the international dollar, redeemable only in American goods and services.

J. H. HOEPEL

Arcadia, Calif.

► *The editorial to which Mr. Hoepel refers was written by McGraw-Hill's Dept. of Economics and appeared in CE (July 1952, p. 37) as well as in a number of other McGraw-Hill publications. It pointed to a coming crisis in foreign trade relations caused by:*

• *Efforts of producers in friendly nations to earn more dollars by increasing exports to the U.S.*

• *Efforts of industries in the U.S. that would be hurt by competition from these imports to keep these imports out.*

*The editorial summed up our dilemma this way: "The people of this country have invested billions of dollars and years of hard work in the attempt to put our allies on a self-supporting basis. If we keep their goods out by raising trade barriers, we are directly defeating our own purposes. . . . At the same time, it must be recognized that certain American industries and their capacity to maintain employment will be hurt by increased imports. Hence it becomes critically important for the United States to formulate a national program designed to help these industries and communities take up the shock. . . ."*

*Our ingenuity in developing new ideas to meet this crisis may well be a decisive factor in our effort to weld the free nations into a strong and durable alliance."*

*Does the Hoeppel Plan qualify as an ingenious new idea? We leave it to our readers' judgment.—Ed.*

### Two Users of Novel Process

Sir:

In your May 1 issue (p. 29) you state that Stauffer Chemical Co. has developed a "novel route to SO<sub>2</sub>" by reacting sulfur with sulfur trioxide, and that first commercial operation was conducted earlier this year.

General Chemical Div., Allied Chemical Corp., has been successfully producing for years, on a multi-ton/day basis, liquid SO<sub>2</sub> of 99.99% purity by a patented process using sulfur and Sulfan sulfur trioxide as charge. Patents on processes utilizing the S-SO<sub>2</sub> reaction include U.S. 2,813,006 (C. B. Hayworth and W. E. Watson) and 2,813,007 (H. S. Hall, C. B. Hayworth and J. W. Swaine).

C. B. HAYWORTH

Allied Chemical Corp.  
New York, N. Y.

### Baghouse Temperatures

Sir:

Our compliments on a good Chementator briefing of the open-hearth baghouse full-scale experiment (Apr. 3, p. 79).

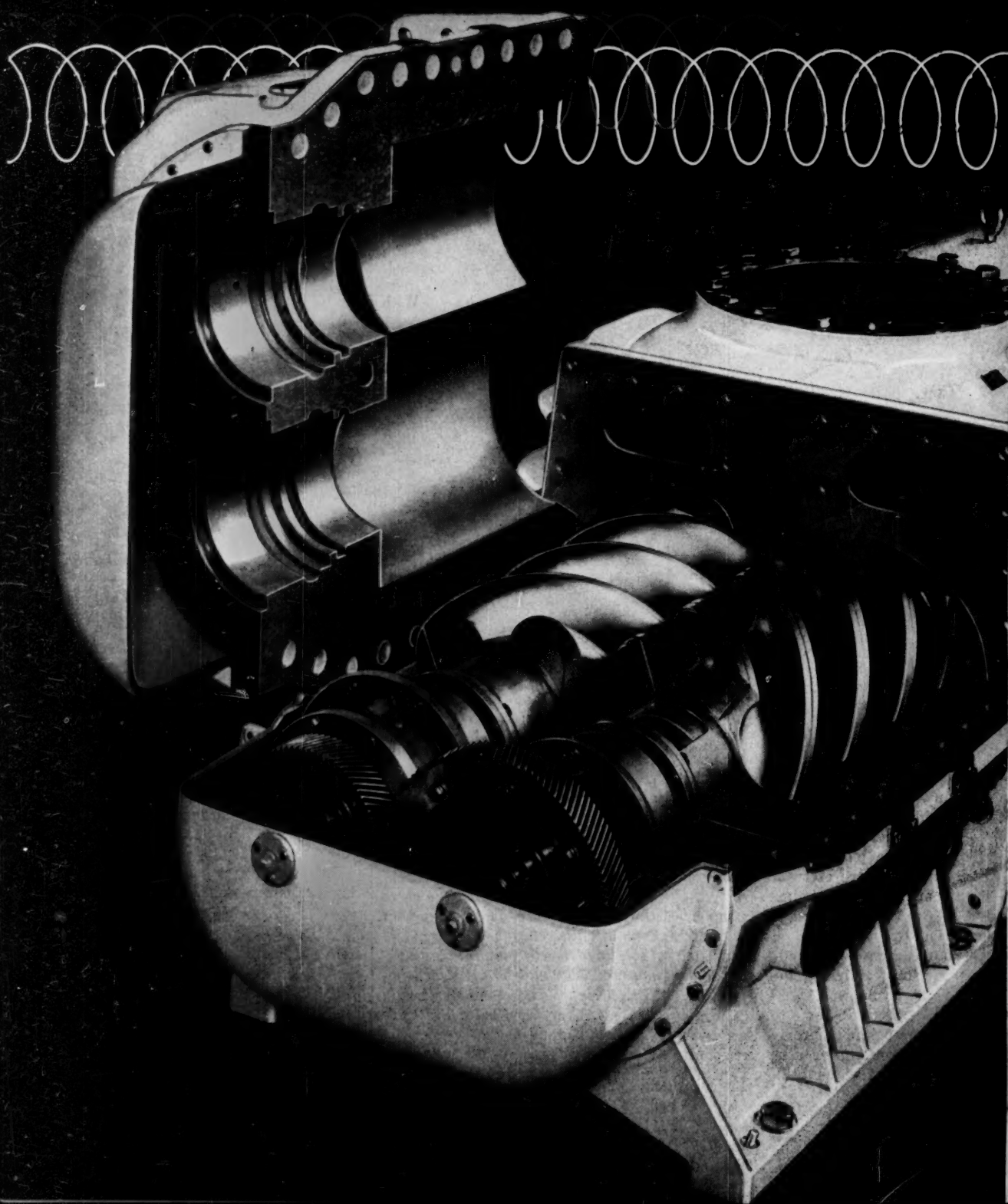
A minor, but important, error was the report of 55° F. instead of the correct 550° F. "cooled gas" temperature to the baghouse.

BENJAMIN LINSKY

Bay Area Air Pollution  
Control District  
San Francisco, Calif.

Your comments and opinions are important. Send them to Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y.

MORE BLUE CHIP COMPANIES BUY F-M COMPRESSORS



BECAUSE MECHANICAL SIMPLICITY MEANS FAR LESS COST!

# F-M ROTARY COMPRESSORS

More and more, industrial leaders are looking-to (and buying) Fairbanks Morse leadership in Compressor design. Why? Because the unique, mechanical simplicity of this *rotary* design combines maximum efficiency and reliability with low initial cost—low maintenance requirements—minimum operating costs. And *skid-mounting* cuts installation time—puts you on stream faster.

The advanced design of the F-M Axial Flow Rotary Compressor features *helical-shaped* rotors for smooth, economical compression . . . with oil-free delivery, surge-free operation on a wide variety of gases.

F-M Rotary Compressors have no reciprocating parts, no valves, no metal-to-metal contact in the compression chamber. Result? Minimum "down-time" expense. They save space—produce minimum vibration—provide stable performance with speed flexibility. Every Rotary Compressor built features famous Fairbanks Morse quality craftsmanship.

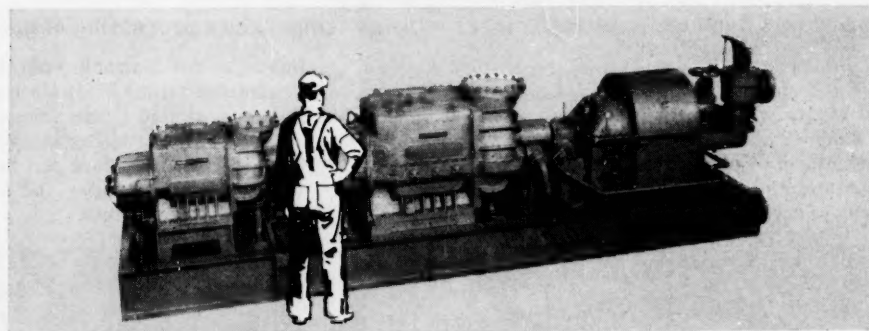
With capacities up to 21,000 cfm—and pressures up to 250 psig, F-M Rotary Compressors are a versatile asset to many operations. Discover how they can step up the efficiency of *your* operation . . . and cut maintenance and installation costs as well. Write: Fairbanks, Morse & Co., Director of Marketing, Compressor Division: Beloit, Wisconsin.

#### THESE INDUSTRIAL LEADERS HAVE BOUGHT F-M LEADERSHIP IN COMPRESSOR DESIGN!

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Phillips Chemical Co.  
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Skid-Mounted, Tandem Rotary Compressor ready for installation at Deere & Company, Waterloo Tractor Works.

Model 200L3/132L3 Fairbanks-Morse Rotary Air Compressor for 12,000 cfm, 110 psig. with 2600 h.p. steam turbine drive.

**FAIRBANKS MORSE**  
A MAJOR INDUSTRIAL COMPONENT OF  
**FAIRBANKS WHITNEY**



## MID-SOUTH CHEMICAL REPORTS...

# *Ammonia refrigerated at less cost with Trane Air-Cooled Exchangers*

**Air-cooled condensers  
eliminate costly water supply,  
maintenance costs.**

The trend toward the use of refrigerated vessels—rather than full pressure—for the processing and storage of liquefied gases is indicated by this new installation.

This Mid-South chemical plant at North Pekin, Illinois uses five TRANE Fluid Coolers—four 15-ton “holding” refrigeration condensers and one 65-ton “filling” refrigeration condenser.

### **Lower Construction Costs**

Refrigerated tanks at Mid-South Chemical are designed for lower pressures and constant maintenance of product temperatures. The tanks, by Chicago Bridge & Iron, are built of lighter steel. And savings on steel were much greater than the cost of insulation and refrigerating equipment.

TRANE units helped make these savings possible.

### **Lower Operating Costs**

Another reason TRANE air coolers were selected by Mid-South Chemical was to eliminate the high and continuing costs of operating water-cooled equipment. If water-cooled equipment were used, 120 GPM of treated water would be required, frequent cleaning of the shell-and-tube condensers would be necessary, and a cooling tower would have had to be built.

### **Lower Maintenance Costs**

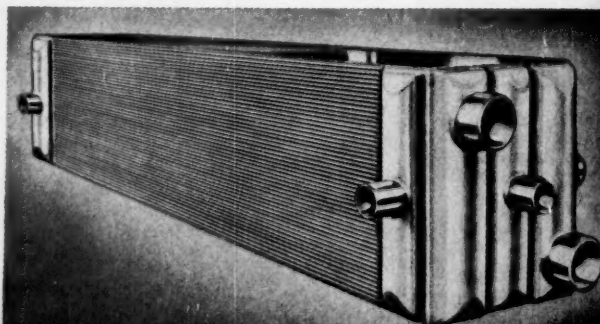
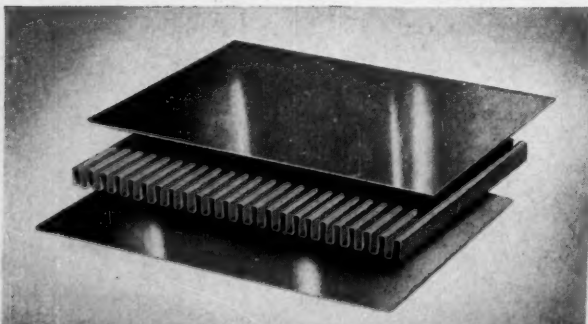
TRANE Fluid Coolers normally need only periodic cleaning of the fin-tube surface. No need for costly maintenance crews . . . spare parts . . . special maintenance facilities and equipment to combat scaling, fouling and corrosion of water-cooled equipment.

**WANT MORE FACTS?** . . . For additional information on any heat transfer problem see your nearby TRANE Sales Office—or write direct to TRANE, La Crosse, Wisconsin.

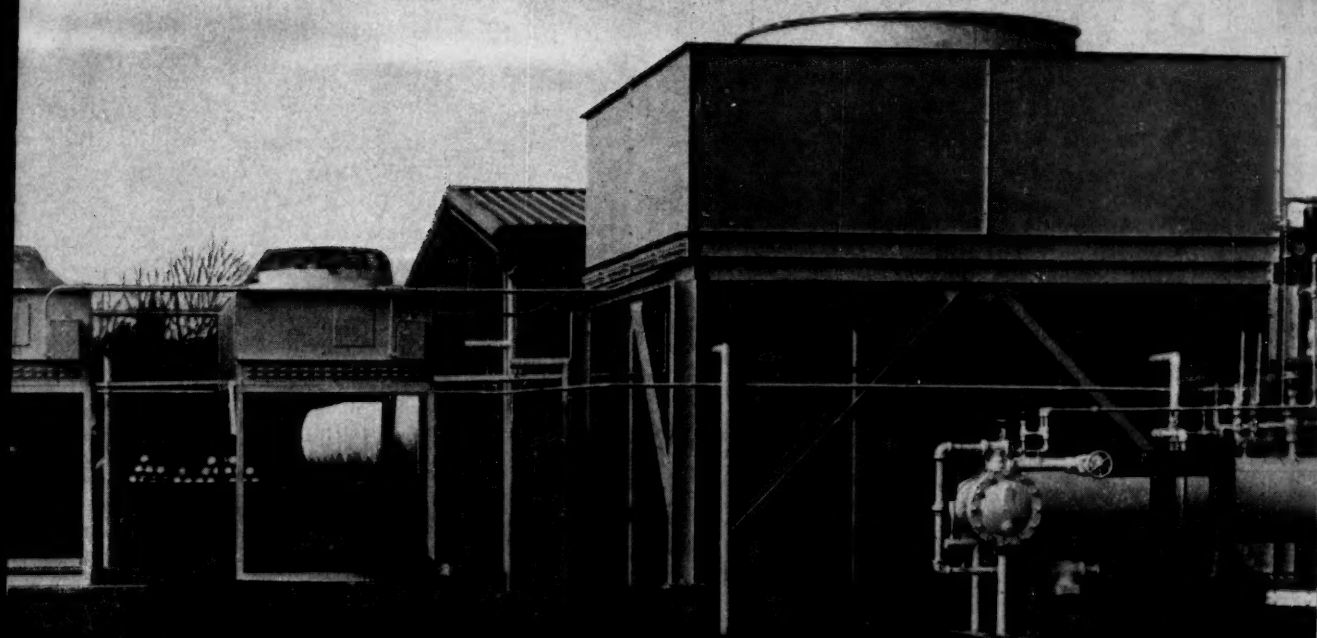
## **TRANE Brazed Aluminum Heat Exchangers—for low temperature processing of gases and liquids**

**Lightweight, compact** TRANE Brazed Aluminum consists of corrugated aluminum sheets brazed together to form a stack of layers which form individual passages for the flow of fluids or gases. Provides up to *nine times* the surface per cubic foot of shell-and-tube exchangers! TRANE Brazed Aluminum Exchangers pack up to 450 sq. ft. of heat transfer surface in one cu. ft.

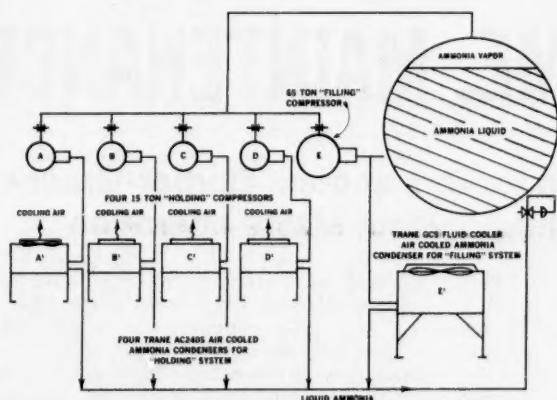
**Headered for 5-stream operation**, this TRANE Brazed Aluminum Heat Exchanger can handle as many as five fluids simultaneously. Units are available for either cross-flow or counter-flow operation. Surface can be fabricated in a wide variety of shapes and sizes to meet all types of requirements.







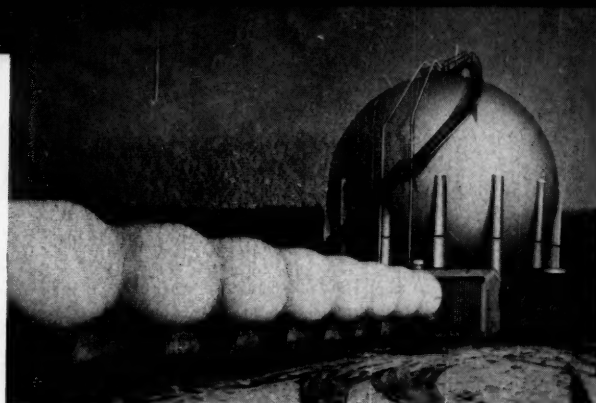
**TRANE Fluid Coolers.** Shown here are three of the four TRANE Fluid Coolers used in Mid-South Chemical's North Pekin operation. TRANE Fluid Coolers have a life expectancy of 15 to 20 years—compared with 7 to 10 years for cooling towers. TRANE has had over 30 years of heat transfer experience.



#### Basics of Mid-South Chemical's procedure

**FILLING**—Liquid ammonia at ambient air temperatures is transferred from conventional high pressure storage to Hortonsphere. During transfer a portion of this liquid flashes to vapor. This vapor is compressed, condensed in TRANE Fluid Coolers and returned to the Hortonsphere.

**HOLDING**—A portion of the liquid ammonia stored at 36°F in the Hortonsphere evaporates to vapor due to solar heat pickup. This vapor is re-compressed, and condensed in TRANE Fluid Coolers—and the liquid is returned to storage.



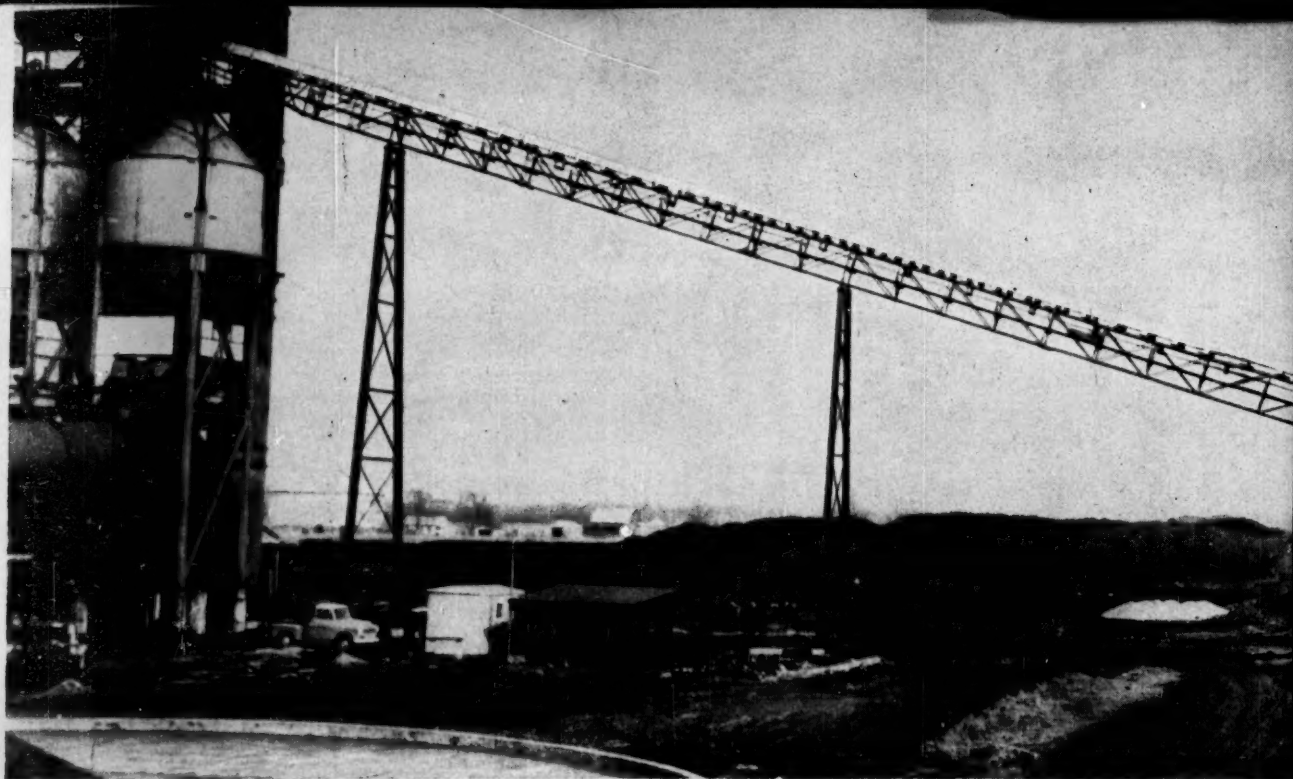
Huge storage capacity is provided by the Hortonsphere. This unit has a 28,000-barrel capacity—equivalent to about 44 blimps like those in foreground.

For any air condition, turn to

# TRANE

*Manufacturing Engineers of Air Conditioning, Heating, Ventilating and Heat Transfer Equipment*

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. PLANT, SCRANTON, PA. • CLARKSVILLE MFG. PLANT, CLARKSVILLE, TENN. • SALT LAKE MFG. PLANT, SALT LAKE CITY, UTAH • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 101 U.S. AND 20 CANADIAN OFFICES.



# **BELT CONVEYORS SOLVE STICKY COKE HANDLING PROBLEM, CUT DOWNTIME, MAINTENANCE**

**General Carbon & Chemical Corp. orders second Barber-Greene installation one month after new system starts operation**

The General Carbon & Chemical Corp. solved a sticky material handling problem at its Robinson, Ill., calcining plant this winter with dual benefits: far fewer production interruptions; and much lower maintenance of the material moving system. And customer satisfaction led to purchase of a Barber-Greene stockpiling system only a month after this installation began operation.

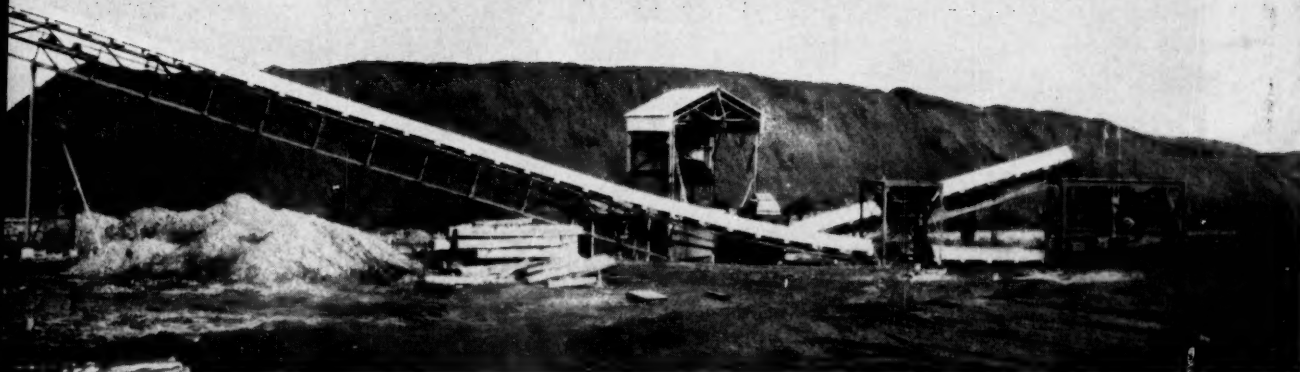
Barber-Greene conveyor specialists, working with company officials and an engineering firm, replaced bucket elevators with trouble-free belt conveyors. The metal buckets had trouble discharging sticky petroleum coke in cold weather and maintenance had been a two-year problem.

Now petroleum coke moves easily and economically at up to 200 tph from railroad cars to two

rotary kilns at this carbon producing plant. The 520' of Barber-Greene Conveyors in the system consist of: 50' apron conveyor under the track hopper; 55' channel conveyor feeding crusher; 388' channel and truss conveyor to main plant; and a 27' shuttle conveyor to charge dual bins above each kiln.

One man operates the entire conveyor system and also controls shuttling of railroad cars.

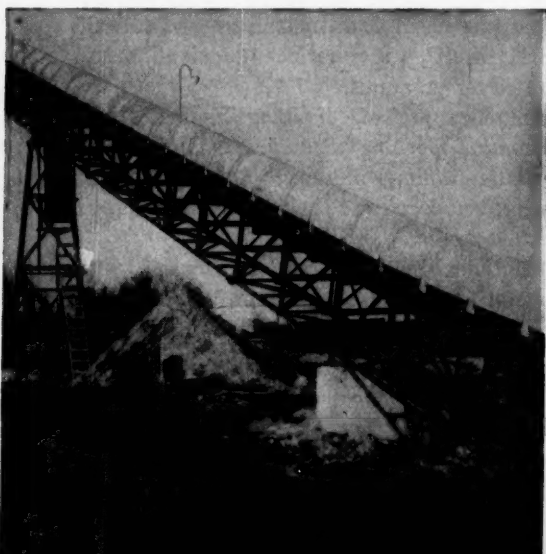
You can achieve an equally sound and profitable solution to your material handling problems by calling in your Barber-Greene Conveyor Representative. He offers most efficient design, lower cost standardized components, fast quotation, delivery and erection on your special or standard conveyor system.



Panoramic view of one-man operated Barber-Greene conveyor system that moves petroleum coke at 200 tph from railroad cars to kilns at General Carbon & Chemical Corp. calcining plant at Robinson, Ill.

Here coke moves from track hopper via apron conveyor to 55' channel conveyor feeding double roll crusher. Crushed coke then is conveyed 388' up grade to kilns.

Typical of many standardized conveyor components employed on job is new 66" truss which allows long spans between support formerly achieved only with expensive galleries.



#### SEND FOR NEW IDLER BULLETIN

New 44-page Idler Bulletin describes the more than 800 units available in the complete Barber-Greene line, tells how their years-ahead features bring longer life and greater economy to every job. Ask for your copy today.

*Your belt conveyor equipment headquarters*

Representatives in Principal Cities of the World

## Barber-Greene

Main Office and Plant AURORA, ILLINOIS, U. S. A.  
Plants in DeKalb, Illinois..Detroit..Canada..England..Brazil..Australia

**CONVEYORS • LOADERS • DITCHERS**

**ASPHALT PAVING EQUIPMENT**



FOR MANUFACTURING ECONOMY...

# SPECIFY FLUOROFLEX



## TO STOP CORROSION, DOWNTIME, AND

Fluoroflex\* has for years been providing superior performance in hundreds of plants here and abroad. Most chemical manufacturers now recognize that Fluoroflex systems lined with Teflon† provide *maximum savings* in production, erection, maintenance, and equipment replacement.

As a result leading engineering-construction firms now use Fluoroflex rigid piping systems and flexible components in new plant construction to stop corrosion or contamination and to reduce erection costs.

These systems are competitive with or cheaper than pressure piping of several high-nickel alloys on an *installed cost* basis. Also there is zero cor-

rosion rate to all acids, chemicals, and solvents to 500°F., except free fluorine and alkali metals at elevated temperatures.

**Fluoroflex preflanged piping** eliminates cutting, chamfering, cleaning, welding, scale, flux, weld spatter and annealing—minimizes the need for gaskets, hangers, supports, and anchors as required for non-metallic piping.

**Fluoroflex reinforced bellows** absorb vibration loads on centrifuges and pumps, and reduce packing leakage. They correct misalignment and expansion-contraction problems on rigid vessels, towers, heat exchangers, etc.

**Fluoroflex transfer hose** combines contamination-





## PRODUCT LOSSES

free hose and flanges with rugged flexibility. Prevents clogging of strainers at critical moments of charging and unloading vessels, tank cars, etc.

Fluoroflex dip pipes, spargers, and thermowells provide the protection of Teflon with the strength of steel to withstand severe agitation or viscous materials without danger of damaging expensive reaction vessels.

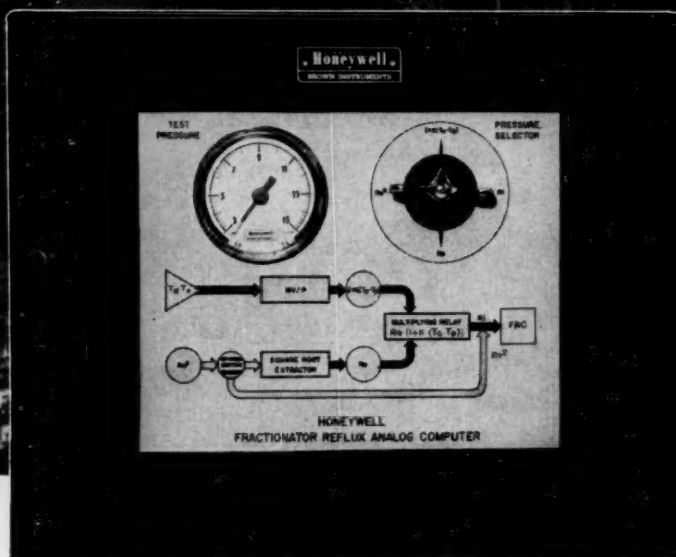
If you have corrosive fluid-handling problems, SPECIFY FLUOROFLEX. Write to Resistoflex Corporation for detailed information today, or ask our local service engineer to call. Plants in ROSELAND, N. J., Anaheim, Calif., Dallas, Tex. Sales offices in major cities. \* Resistoflex T.M. † DuPont T.M.

# RESISTOFLEX RELIABILITY

COMPLETE SYSTEMS FOR CORROSIVE SERVICE



# Stabilize Fractionating with new Honeywell



## HONEYWELL FRAC CONTROLLER IS EASY TO USE AND MAINTAIN

- Standard Honeywell components, packaged in a standard Honeywell strip chart recorder case—completely wired and internally piped.
- Only four simple, easily accessible process connections required to put the unit in operation.
- Chassis pulls out for front-of-case servicing, simplifying adjustment and maintenance for your instrument technicians.

### COMPONENTS

**MV/P (millivolt-to-pressure) Transmitter**

- Fully transistorized

- Continuously sensitive to temperature change
- Constant voltage supply
- Simple span and zero adjustments

### Pressure selector and test pressure gage

- Provide check of all pneumatic pressures within the computer for simplified trouble shooting.

### By-pass switch

- Permits switching from *FRAC* control to conventional external reflux flow control.

# Column Operation

## FRAC\* Controller

- Easily installed and maintained by present instrument technicians
- Savings realized justify installation
- Tamper-proof design

This new Honeywell control system immediately adjusts column operation to the effects of ambient temperature on overhead product condenser and external reflux. It continuously computes internal reflux flow, to maintain the most efficient, economical fractionating tower operation.

The new method, originally developed and licensed by Phillips Petroleum Company, utilizes a simple Honeywell analog computer employing standard Honeywell electric and pneumatic instrument components.

By correcting instantly for temperature deviation, the new control system offers the following economies.

- Less reboiler heat is required, because large surges of internal reflux that would lower temperature are eliminated.
- Reduction in off-specification product minimizes re-runs and the need for intermediate storage.
- Closer control permits fractionator to operate closer to the flooding point.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

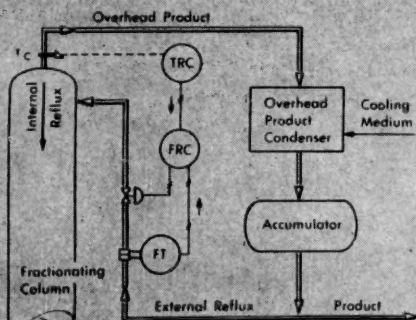
\*Fractionator Reflux Analog Computer. Trademark, Minneapolis-Honeywell Reg. Co.

from Honeywell...  ANOTHER DIAMOND JUBILEE PRODUCT

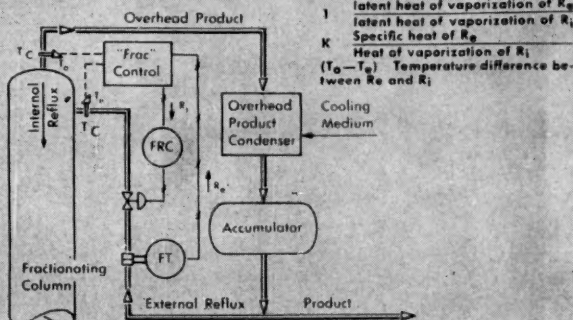
# Honeywell



*First in Control*  
SINCE 1885



**PROBLEM** with existing fractionator control systems—Column is upset when temperature of external reflux is indirectly affected by changes in atmospheric conditions or in the temperature of the cooling medium to the condenser. Result: off-spec product, wasted reboiler heat, lower fractionator capacity.



**SOLUTION:** FRAC Controller (1) measures external reflux flow rate ( $R_e$ ) and the temperature difference between the overhead product ( $T_o$ ) and the external reflux ( $T_e$ ); (2) computes internal reflux flow rate ( $R_i$ ); and (3) holds it constant by adjusting external reflux flow rate for efficient fractionator operation.

$R_i$   $R_e (1 + K (T_o - T_e))$   
 $R_i$  Internal reflux  
 $R_e$  External reflux  
 $i$  latent heat of vaporization of  $R_e$   
 $K$  Specific heat of  $R_e$   
 $(T_o - T_e)$  Temperature difference between  $R_e$  and  $R_i$

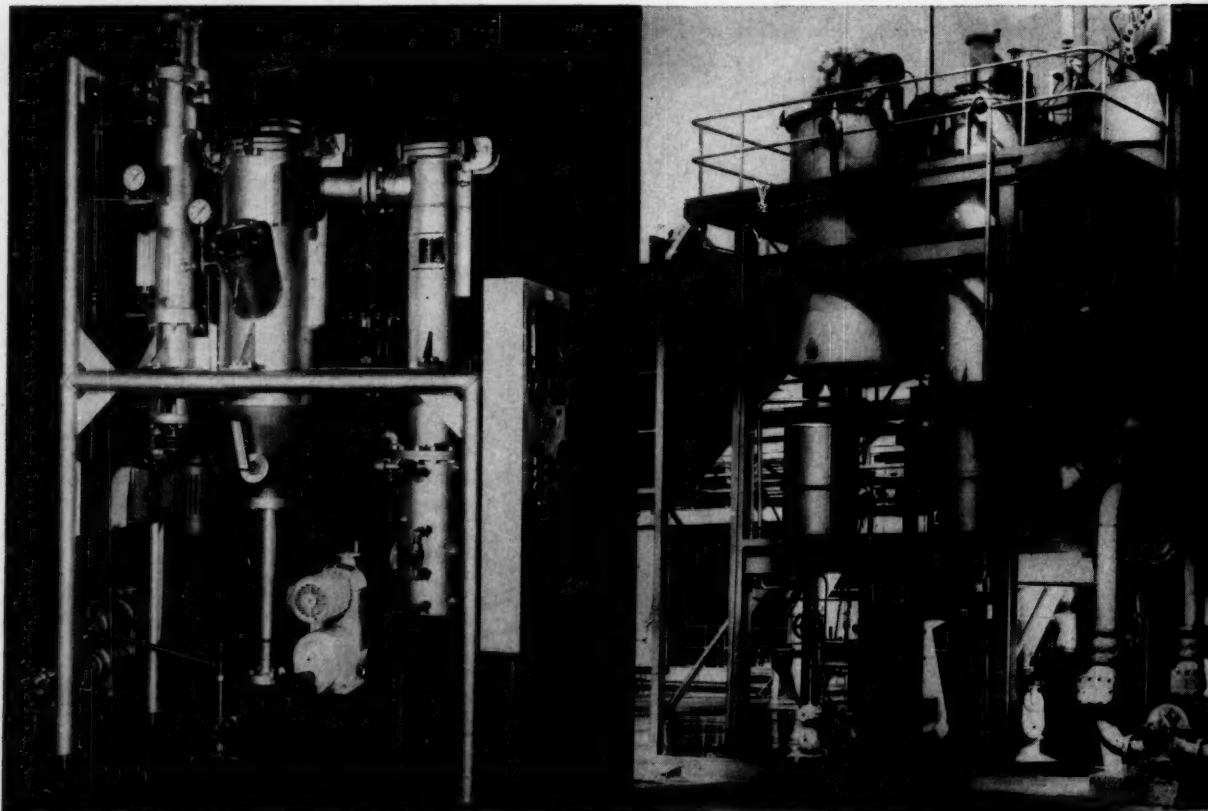
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# how to concentrate and dry viscous heat-sensitive materials

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A 4 sq. ft. Roto-Vak with a vertical surface condenser built for a research laboratory to develop processes for the concentration of various products. All parts in contact with the product are fabricated of polished stainless steel. All operations are controlled from the panel board.

A Processing Plant consisting of a Bufllovak Double Effect Evaporator shown partially in the right background, a 100 sq. ft. Roto-Vak with Separator, Feed Tank and auxiliary equipment. Feed Tank for the Double Effect Evaporator is in the upper left foreground. The finished product from this plant is a heat-sensitive paste. Adding the Double Drum Dryer shown in the flow diagram, or a Bufllovak Flaker, would allow production of a flaked material.



The Buflvak Roto-Vak is an "Agitated Film" Evaporator for high capacity heat transfer. It quickly processes many products to densities heretofore impossible to obtain.

It is the only agitated film "true down-flow" type in which the liquor and vapor pass vertically down the central vaporization tube and discharge into a highly efficient, easily cleaned liquid-vapor separator.

The Roto-Vak provides the Chemical and Petroleum industries with a processing tool to produce new products, to lower production costs of existing products, and to improve product quality. When used as a finisher, following a single or multiple effect evaporator, the operating economies and production gains have been exceptional.

### ROTO-VAK CHARACTERISTICS

- High capacity heat transfer for viscous, heat-sensitive materials.
- Non-destructive concentration of a wide range of viscous materials to densities heretofore impossible.
- Short, controlled contact time (matter of seconds).
- Higher heat transfer rates due to the highly turbulent, thin-film action.
- Contacts through a wide temperature range easily controlled and reproduced to suit the product.
- Processes any material which can be pumped.
- Used to REACT • COOL • HEAT CONCENTRATE • DEHYDRATE DEODORIZE • EVAPORATE STRIP • DEAERATE.

### OUR CUSTOMER

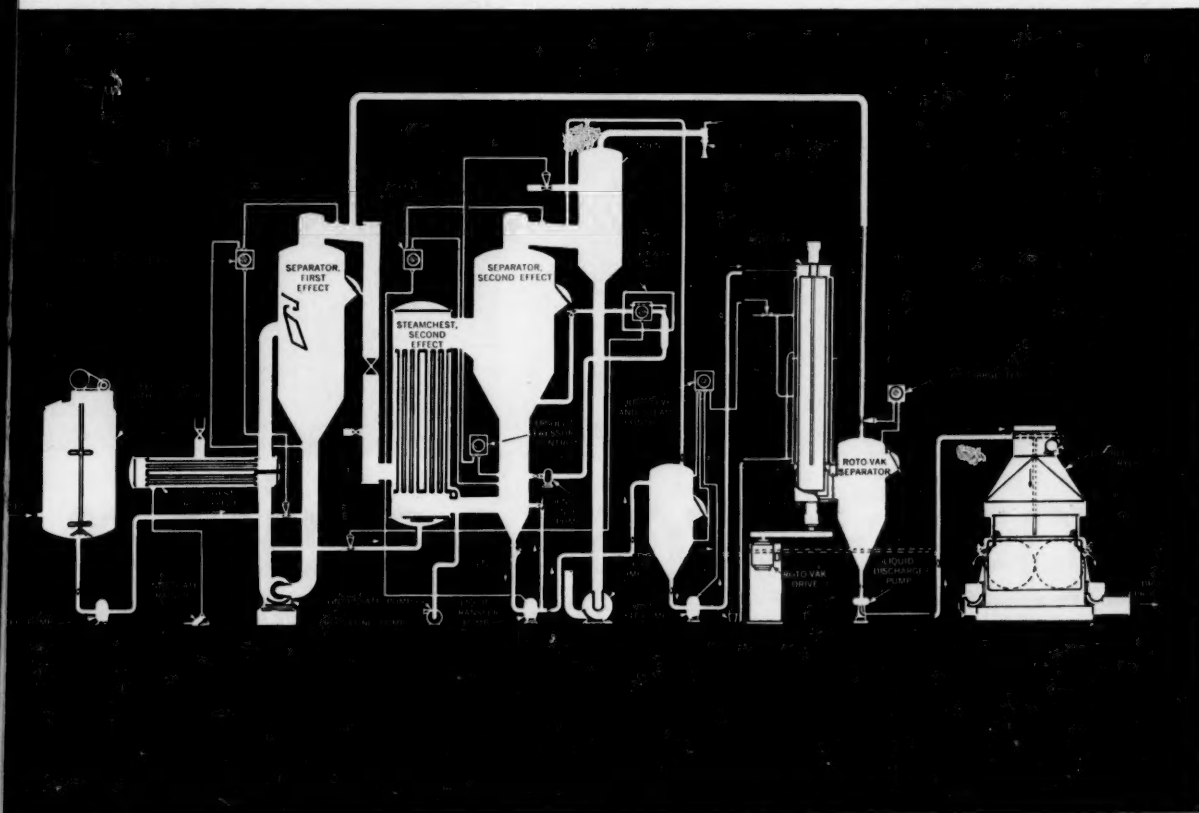
#### TECHNICAL SERVICE LABORATORY SOLVES A PROCESSING PROBLEM FOR SOMEONE EVERY DAY

We have a completely equipped laboratory that can help you test your new products. Pilot plant models can be set up for evaporation, drying or other types of processing operations. We do this for other companies. We can do it for you, too. Call or write for Catalog 381 describing the facilities available. Buflvak Equipment Division, 1551 Fillmore Avenue, Buffalo 11, New York.

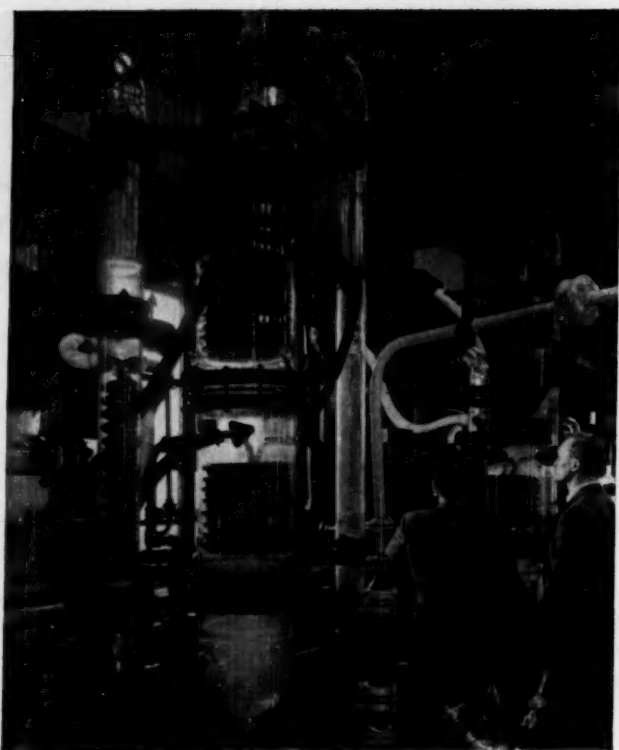
## BLAW-KNOX

### Buflvak Equipment Division

Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms • Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes • Towers and Special Structures • POWER: Power Plant Specialties and Valves

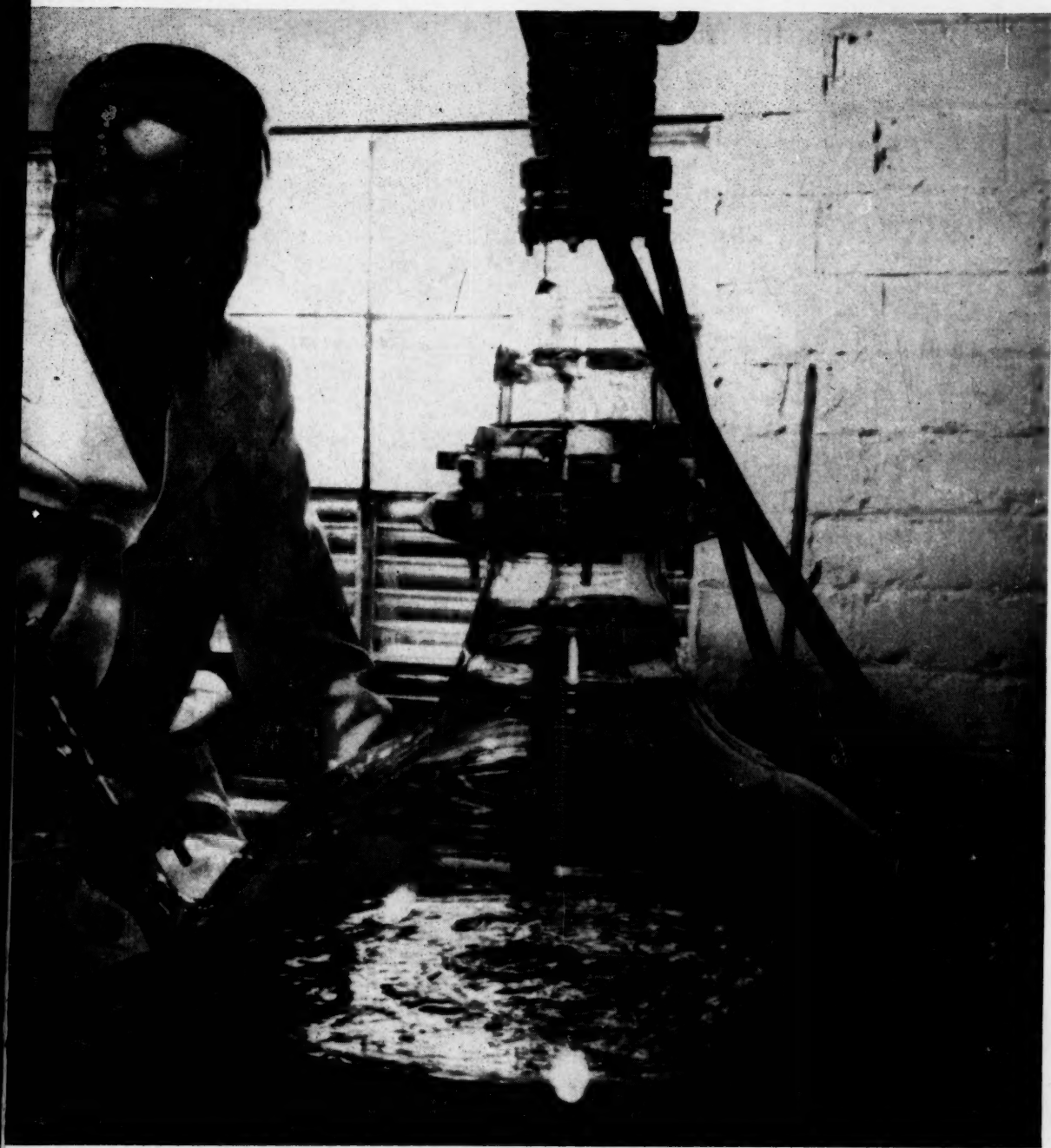






# Now you can have complete unit processing in glass





Put corrosion resistance, visibility, low cost—all the advantages of glass—to work in plant processing units.

Now we can design these processing units for you from QVF components\* made of borosilicate glass. Components which range in size up to 200-liter vessels, 18-inch-diameter columns, 60-square-foot heat exchangers. Made of a glass which ties in chemically and thermally with your present PYREX® pipe, fractionating columns, and heat exchangers.

Our Plant Equipment distributors have these com-

\*Manufactured in England by James A. Jobling & Company, Ltd., Corning affiliate and licensee.

ponents in stock, immediately available. Our engineers are ready to help you choose the right components for your process—production of hydrochloric acid, pharmaceuticals such as cortisone, insecticides, or whatever.

For more information on the possibilities, advantages, and economies of unit processing your product in glass, write Plant Equipment Department, 8906 Crystal St., Corning, New York.



**CORNING GLASS WORKS**

CORNING MEANS RESEARCH IN GLASS

The Westinghouse man with the motors brings you—

**New Class B Insulation  
to give you 15%  
more horsepower  
on totally-enclosed  
Life-Line motors**





Now Class "B" Insulation replaces Class "A" as standard on totally-enclosed 1-250 hp Life-Line a-c motors giving you these advantages:

**Added capacity . . .** Operation at 15% over name-plate rating without reduction in motor life.

**Longer life . . .** 80% to 100% longer life at rated loads than motors with Class "A" Insulation.

This newly designed motor is engineered to give top performance in a wide range of applications. On-the-line experience in the steel industry, where maximum reliability is essential, has proved its higher output, longer life and lower maintenance under the toughest conditions.

**For the ultimate in protection** specify Guardistor\* on all Westinghouse motors. This exclusive built-in static motor protection allows the use of maximum horsepower over long periods with no danger of motor burnout.† For additional information ask for booklet B-7876-A.

Your Westinghouse sales engineer can supply you with complete details on these money-saving motors. Call him for full information on how they can fit into your production scheme. Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania.

*You can be sure . . . if it's Westinghouse.*

\*Trademark

# Westinghouse



†Warranty: Westinghouse GUARDISTOR MOTORS on frames 182-445 inclusive are guaranteed for one year against burnouts due to overheating resulting from: overload, locked rotor, blocked ventilation, bearing seizure, single phasing, unusual duty cycle, high ambient, or voltage unbalance, providing the Guardistor elements are connected in a control circuit so that the motor is removed from the power source in the event of over-temperature.

J-22170



## New IBM Inventory Management Simulator

# Management pre-tests inventory

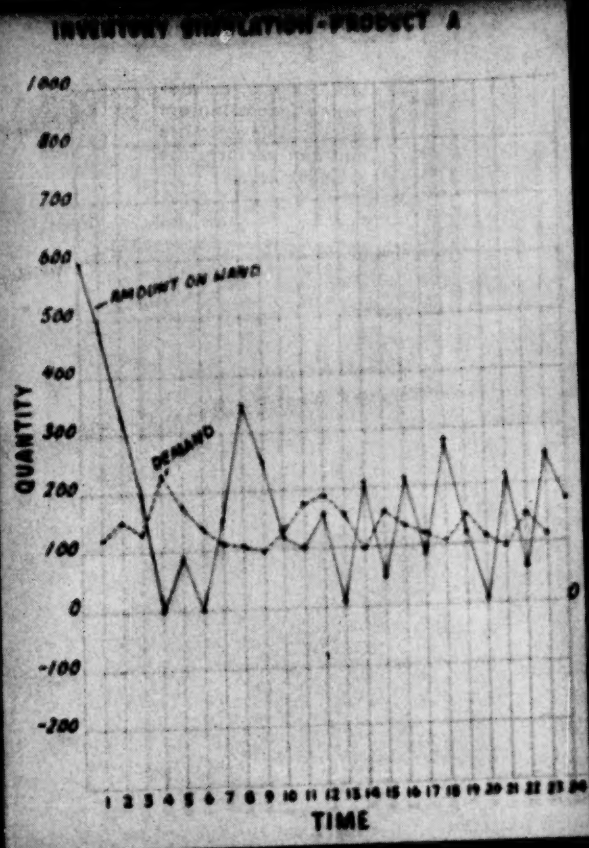
**How often have you wanted** to peer into the future... see the probable results of your inventory policy? **Now you can.** An IBM data processing technique—Inventory Management Simulation—establishes the computer as an invaluable management tool for problem solving and decision making.

This technique lets you test and evaluate alternate plans electronically without disrupting present operations. In effect, it lets you turn *hindsight* into *foresight*.

**Simulation is performed** by creating within the computer a mathematical model of an inventory

control system. Then the model is subjected to various demand situations. In every case, the computer reports what would have happened had this particular system been used to handle each situation. Of course, both the model and the demand factors can be endlessly varied.

**Here's the important thing:** Through simulation, the trial-and-error method of determining a course of action is performed within the computer—not during the course of your firm's business. This gives you a fast way to test plans under a wide range of conditions before actually putting them



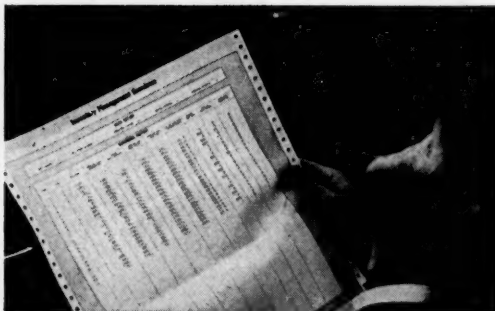
**LOOKING AHEAD.** Management has run a computer simulation of a proposed inventory plan. Company executives (above) now examine charted results showing how the plan might work, what problems might arise, where improvement might be sought. Print-out sheet (below) from an IBM computer contains facts needed to judge long-range results of a given inventory control plan. Inventory Management Simulation takes much of the guesswork out of planning.

## decisions with electronic speed

to use. Unprofitable or inadequate courses of action show up in advance. You avoid them. And you select with confidence the system best suited to your firm's objectives.

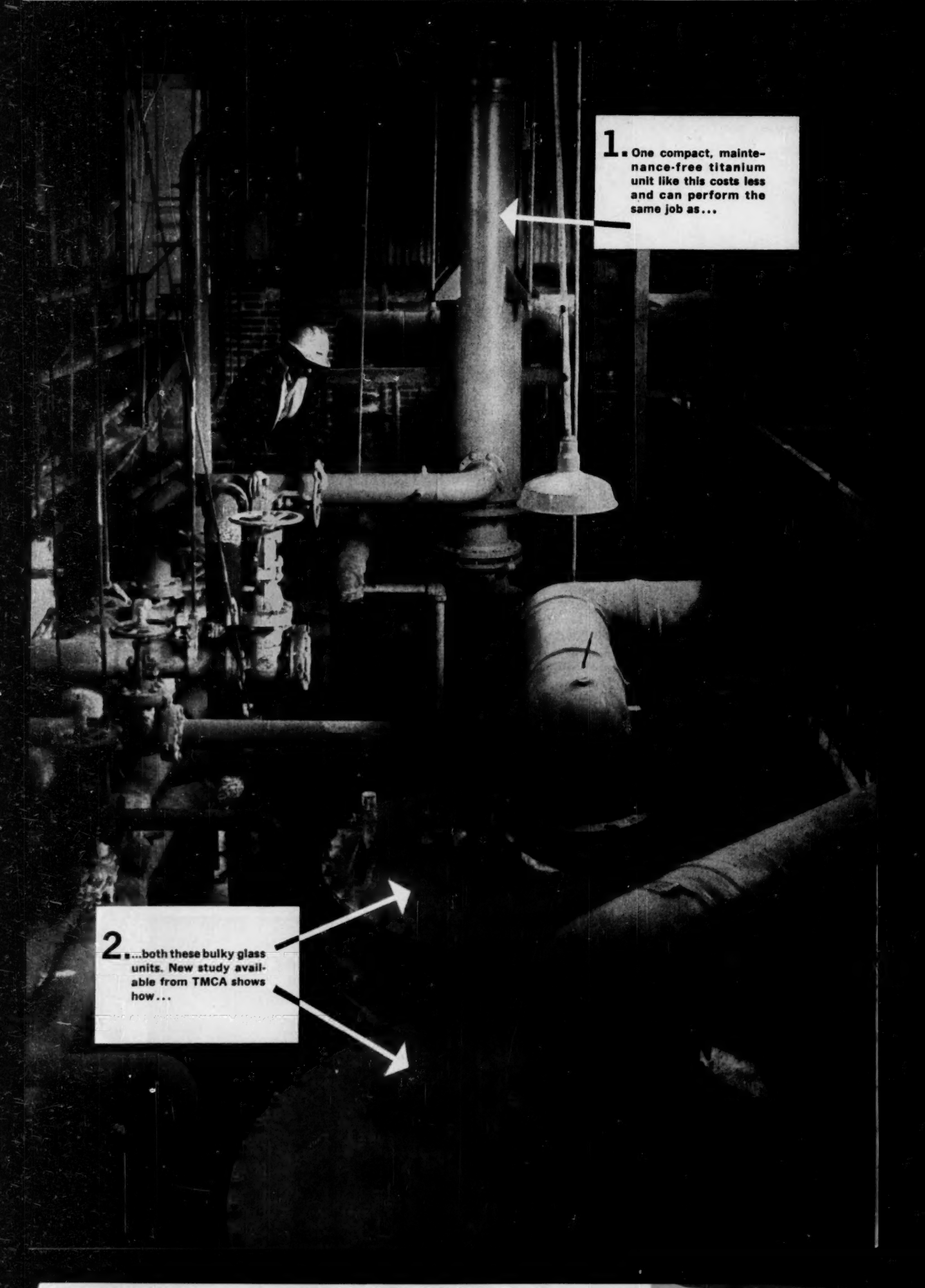
**Getting started.** If you are an IBM customer, you can take advantage of the Inventory Management Simulation Program at once. IBM helps you collect the facts you need...and helps you set up a computer program to analyze them.

Ask your IBM representative to show you how this new technique can uncover *your* most effective inventory policy.



**IBM**<sup>®</sup>  
DATA PROCESSING





**1** ■ One compact, maintenance-free titanium unit like this costs less and can perform the same job as...

**2** ■ ...both these bulky glass units. New study available from TMCA shows how...

*In wet chlorine...*

## Lifetime **Titanium** heat exchangers return 30% on investment, pay for themselves in 2.5 years

According to a new economic study now available through Titanium Metals Corporation of America, titanium heat exchangers for cooling chlorine cell gas can return 30% after taxes on their investment, and pay for themselves in two years and a half, when depreciation is considered.

At the same time they reduce maintenance, increase operating efficiency, save space or allow the use of what is normally wasted space, and eliminate possible product contamination through tube failure.

In existing plants already using contact coolers, the substitution of titanium heat exchangers for steam stripping returns comparable amounts...23% and more on the added investment and a pay-back in three years or less.

These startling returns are gained primarily through reduced operating costs. As the study reveals, a plant producing an average 100 tons a day can save more than \$20,000 a year through the use of titanium coolers.

Glass tube coolers, on the other hand, fare less well. In comparison with titanium used in indirect cooling, their initial cost is higher; the return on investment is lower (8.8%); the pay-out time much longer (5.3 years).

### WHY TITANIUM?

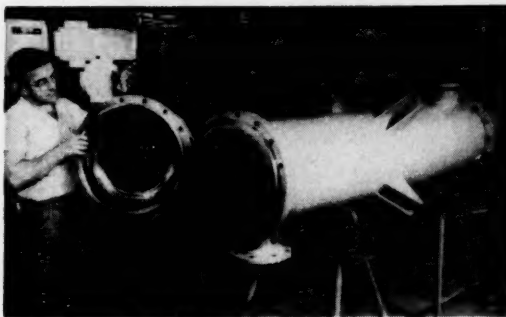
**High performance.** Among the reasons for titanium's success in this important application are its absolute immunity to wet chlorine corrosion...its lightness and strength, even at high temperatures...its ease of fabrication...and its heat transfer properties, which are significantly better than glass.

**Titanium unit costs lowering.** TMCA composite price index has dropped from \$15.25 in 1954 to \$6.97 per pound by early 1961. As fabricators have come to realize that titanium is as easy to fabricate as most steel alloys, these costs have dropped too.

The present study is based on the current price of titanium heat exchangers, which now range from \$25 to \$30 per square foot, a considerable reduction over the recent past.

**Stauffer unit saves space, more efficient.** Stauffer Chemical Company, Niagara Falls, N. Y., has a titanium heat exchanger in chlorine cell gas cooling. The titanium unit requires far less space than either of two glass units and yet can carry the same load as the glass units combined. The titanium heat exchanger is installed in relatively inaccessible, formerly "waste" space, since the unit requires no maintenance. Glass coolers require three to four downtimes a year. Stauffer also reports that the titanium cooler operates at greater efficiency and reduces the amount of sulfuric acid needed in final cooling.

**How TMCA can help you cut chlorine cell costs.** First, write for the study, "New Economies in Cooling Chlorine." If titanium units appear to be able to help you in your battle against cost—and it is highly likely that they can—talk to Titanium Metals Corporation of America. TMCA's Technical Service Department can put you in touch with competent fabricators and supply the technical data needed to help you trim your costs and boost your process efficiency in wet chlorine...inhibited sulfuric acid...hypochlorites...acetic acid...nitric acid...and other corrosive applications. Write today!



Heat exchanger containing 268 titanium tubes, is used in Stauffer Chemical Company's Niagara Falls, N. Y., plant to cool chlorine gas from 75°C to 40°C. The titanium unit, providing 394 square feet of heat exchange surface area went into operation in 1959, shows no sign of corrosion and needs no maintenance.

**This important study is available  
to you at no cost.  
"NEW ECONOMIES IN  
COOLING CHLORINE."**



**TITANIUM METALS  
CORPORATION OF AMERICA**  
233 Broadway, New York 7, N. Y.

SALES OFFICES: NEW YORK  
CLEVELAND • CHICAGO • DALLAS • LOS ANGELES

To produce inerts in any quantity, for any job...

# KEMP INERT GAS GENERATORS

*-are best 3 ways!*

## 1. Easy to start, set and forget

With Kemp's unique carburetor and external test burner, you check the pre-mixed gas-air ratio *before* it enters the combustion chamber... start fast with the electric ignition. Then set the vernial dial and forget it! The carburetor maintains the exact air-gas ratio—no rechecking needed.

## 2. Precise fuel control

You'll find the Kemp Carburetor automatically pre-mixes and keeps gas and air at the exact mixture you wish. And no matter what the total demand or pressure changes in your supply line, this precise air-gas ratio is maintained at all times.

## 3. Automatic safety

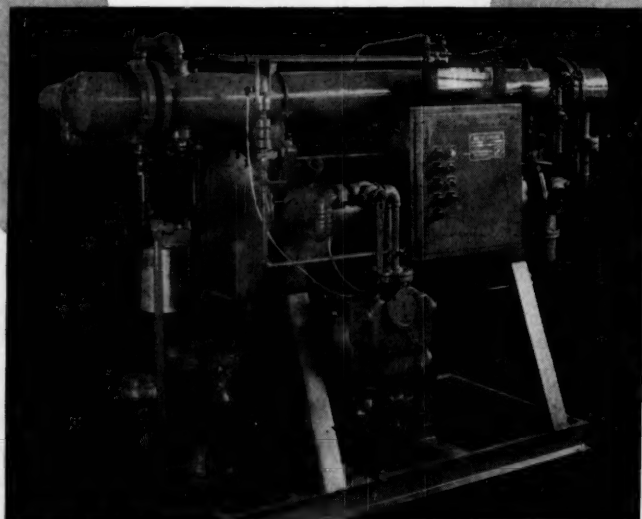
Kemp safety controls eliminate the danger of flame-out. An electronic flame-failure control instantly, automatically cuts off the carburetor's gas supply. This control operates under all conditions... unaffected by moisture or combustion chamber pressure.

If you need inert gases for blanketing, purging and protective uses, write for Bulletin L-10... or call in your Kemp Man listed in the yellow pages or the Chemical Engineering Catalog.

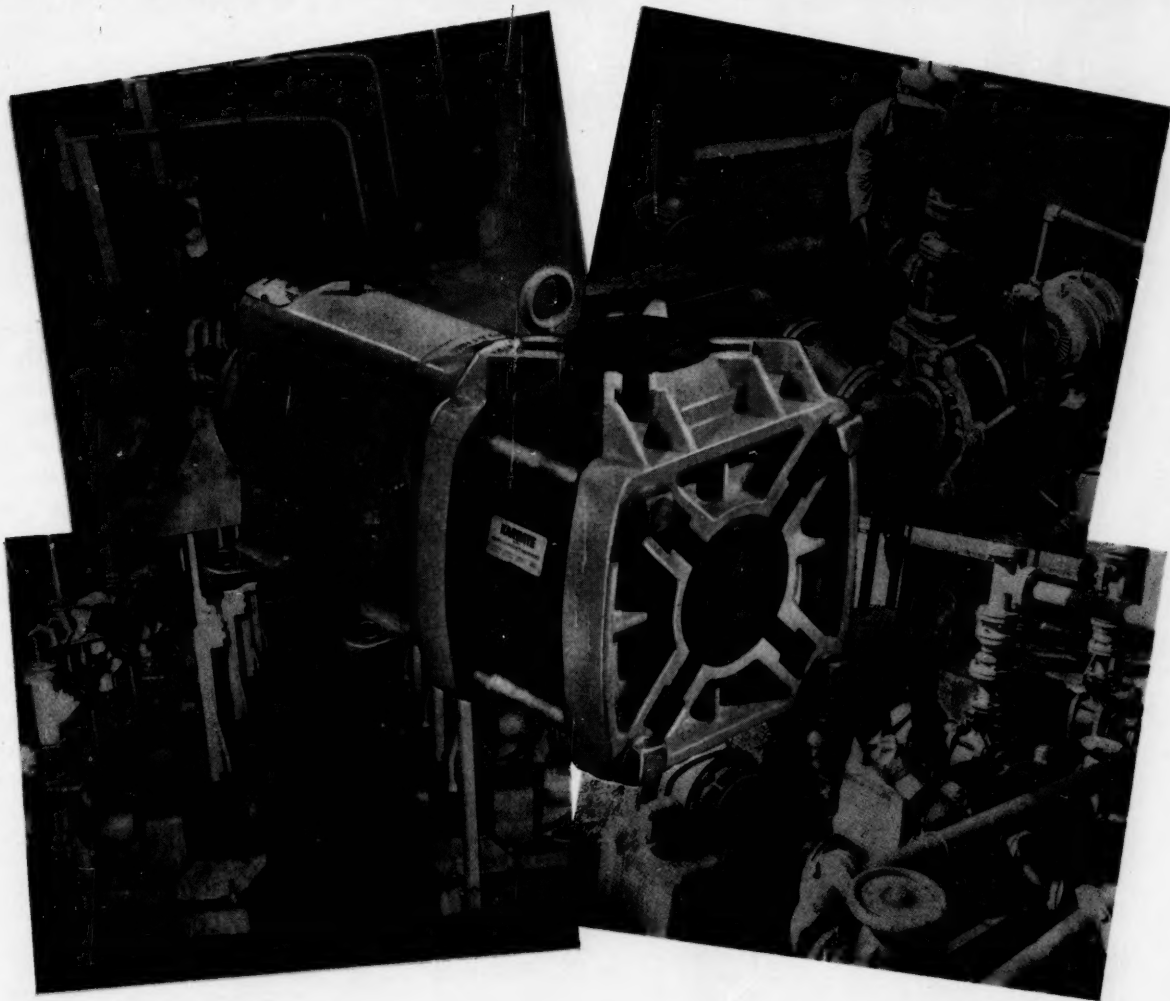
*It always pays  
to come to*

**KEMP**  
OF BALTIMORE

THE C. M. KEMP  
MANUFACTURING COMPANY  
405 E. Oliver Street • Baltimore 2, Maryland



# NEW FRAME-MOUNTED MODELS EXPAND "KARBATE" PUMP LINE!



National Carbon's addition of "Karbate" frame-mounted Type F pumps to its line provides today's widest selection of impervious graphite centrifugal pumps!

Designed and built by the world's leading producer of non-metallic centrifugal pumps, the new Type F has 1, 1½, and 2-inch discharge openings, and features the same wet end parts and mechanical seal used on proved motor-mounted models.

With capacities to 140 gpm and heads to 67 feet, the new frame-mounted Type F brings to 32 the num-

ber of standard sizes of "Karbate" impervious graphite pumps . . . offering discharge openings ranging from 1 to 4 inches, capacities from 5 to 1500 gpm, and heads from 15 to 120 feet.

You can depend on the unsurpassed corrosion resistance of "Karbate" impervious graphite centrifugal pumps for all corrosive pumping service. For details on models and sizes, write: National Carbon Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. In Canada: Union Carbide Canada Limited, Toronto.

"Karbate" and "Union Carbide"  
are registered trade marks  
for products of

**NATIONAL CARBON COMPANY**





# ANOTHER Money Saving Feature

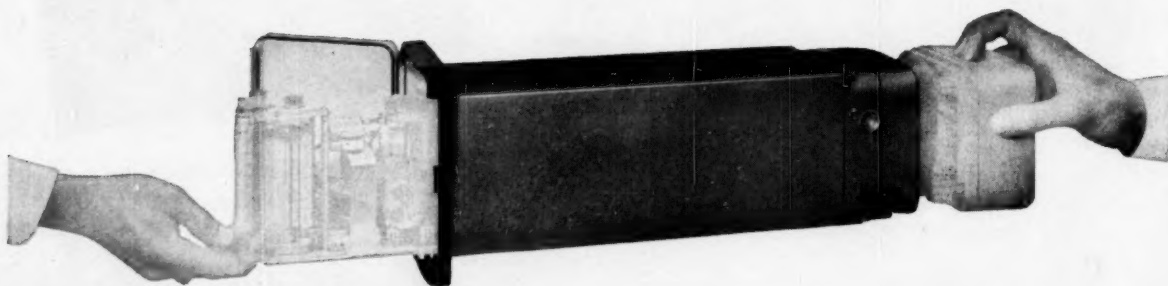
OF  
*Taylor Instruments*

## FASTER DELIVERIES

You save up to six weeks delivery time on TRANSCOPE® Recorders and Controllers.

**Here's how:** We can ship you TRANSCOPE housings with manifolds within 2-4 weeks of receipt of your order. The unique plug-in features of the 90J pneumatic and 700J electronic recorders and TRANSCOPE controllers enable you to install these housings and make all necessary connections to the tagged manifolds while we complete manufacture of the instruments. You will then be ready to plug in recorder-controllers on delivery—approximately 4-6 weeks later—and be on stream immediately.

**This saving in time** is possible because the same plug-in features that enable us to ship the housings early permit our Production Department to build up a reserve stock of separate housings and built-in manifolds. We are geared to large quantity production that assures fulfillment of this delivery schedule.



*Speedier delivery is another plus value of the TRANSCOPE line, now recognized throughout industry for its many outstanding features. Ask your Taylor Field Engineer, or write for Bulletin 98286 (pneumatic) or 98335 (electronic). Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ontario.*

*Taylor Instruments* **MEAN ACCURACY FIRST**

# ACE

## TEMPRON

NITRILE HARD RUBBER

### THE HOT MATERIAL FOR HOT CHEMICALS

All the chemical resistance of nitrile hard rubber... plus heat resistance well above boiling up to 260 or 275 deg. F.! No wonder Tempron's growing so fast! You can buy it now in a full range of pipe sizes, or as sheet and molded parts for fabricating.

Tempron is a new *hard* rubber... with greater chemical resistance than previous soft or hard nitrile rubber. Stays staunch and rigid in heat well above the upper limits of common plastics. Handles most acids, alkalis, and salts, and has excellent resistance to organic chemicals such as aliphatic hydrocarbons. Tensile strength 7,500 psi. at 73.4° F.

■ **TEMPRON PIPE:** Rigid, chemical and heat-resistant pipe is made in sizes from 3/4" to 8". Threaded fittings to 4", flanges to 6". Easy to thread with standard tools.

■ **TEMPRON SHEET FOR FABRICATING:** Excellent strength and abrasion resistance, for plating barrels and other special equipment. Also extruded rod and tube. Easily machined.

■ **TEMPRON MOLDED PARTS:** Economical for special fittings and other molded parts. Ask also about hand fabricating of large parts such as tanks, trays, headers, etc.



Get the facts today: Ask for Tempron Bulletin 96A.  
Better still, tell us what and we'll tell you how.

CHEMICAL EQUIPMENT DEPARTMENT



## American Hard Rubber Company

ACE ROAD, BUTLER, NEW JERSEY • Tel.: TE 8-1000



Rubber-lined steel tanks and special equipment. Also custom lining compounds for field application. Bul. CE-53.



Rubber-lined steel pipe combines strength of steel with chemical resistance of Ace Hard Rubber. Bul. CE-51/52.

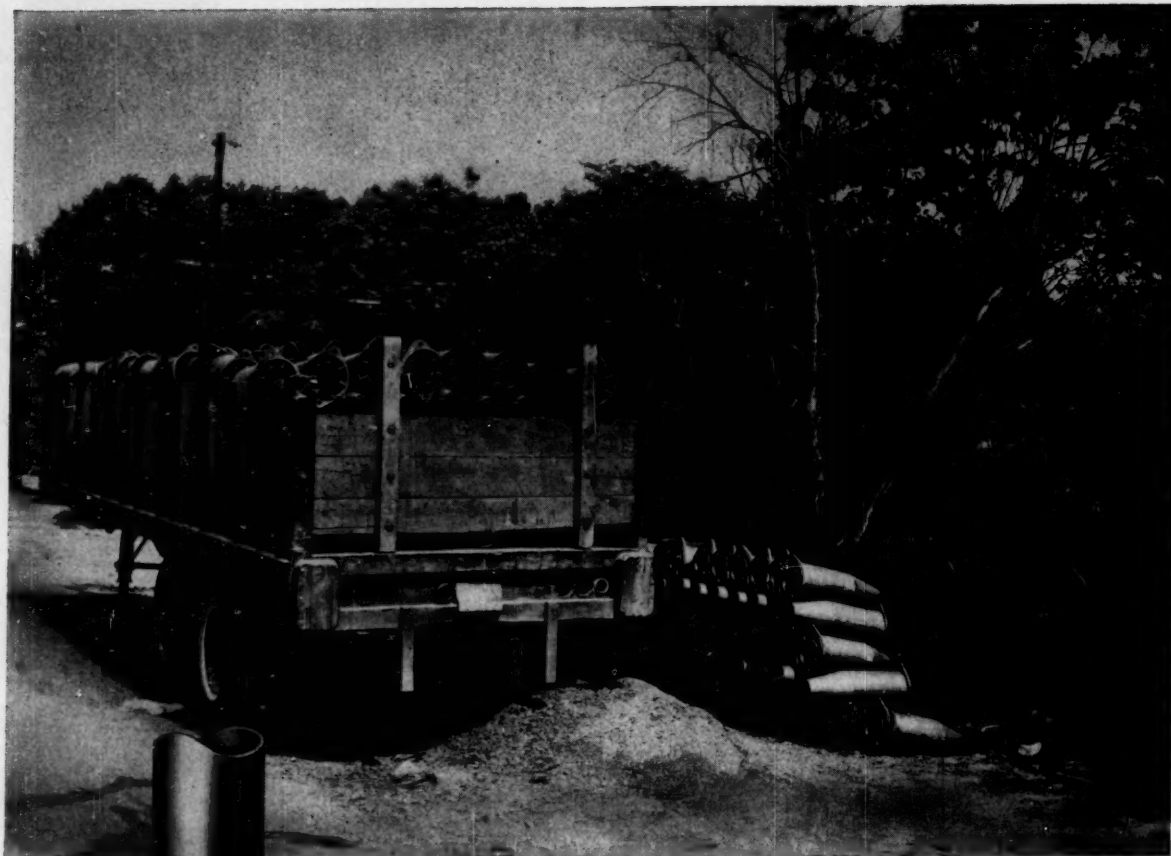


Acid pumps, centrifugal and gear types, fully protected by Ace Hard Rubber. Full line to 350 gpm. Bul. CE-55.



Ace Rubber-lined valves wear on when others wear out. Fully protected gate, diaphragm, check, and plastic types. Bul. CE-51/52.





TYPE  
C10  
CYCLO-TRELL

## **Ammunition for the war on dust!**

Fighting dust is the purpose of this load of Cyclo-trell C10 "shells." ■ Cyclo-trell units for process gas or air cleaning in steel mills, refineries, paper, cement or chemical plants give you high efficiencies. ■ Engineered to fit each specific job, Cyclo-trell units are available in a wide range of sizes and types including C10, C24, IC (Involute Cyclo-trell) and ICL (Involute Cyclo-trell, Lined). ■ Why not let us consult with you on your specific dust collection problems? For further information, write for Bulletin 300 which describes several applications in detail.

# **Research-Cottrell**

RESEARCH-COTTRELL, INC., Main Office and Plant: Bound Brook, N. J.

Representatives in principal cities of U.S. and Canada

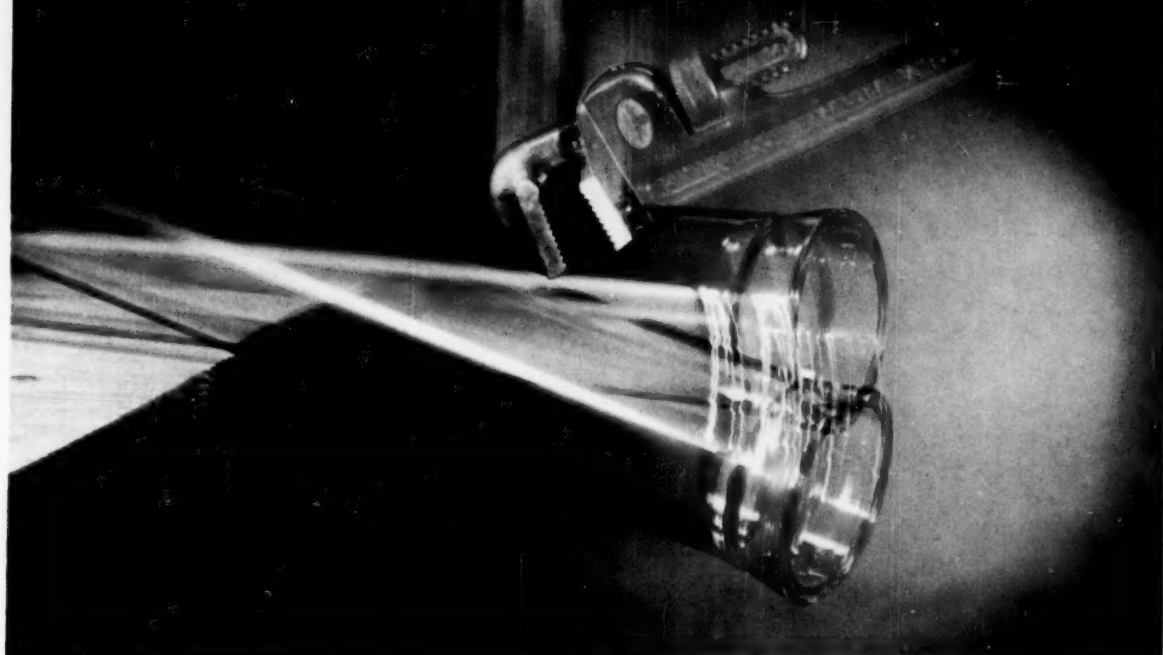


RC-200

## NEWS!

From Kimble Craftsmanship  
The perfected glass pipe

**KIMAX...**



Kimax Tempered Glass Pipe never affects your product.

### ***Made rugged for amazing resistance***

One of the many benefits of Kimax Tempered Glass Pipe is its ruggedness. Selective tempering and one-piece construction give an unusual degree of mechanical strength and resistance to normal abuse.

Yet this pipe is light in weight for easy handling and installation.

It has amazing heat resistance—operating in temperatures up to 450°F. It shrugs off heat shock to permit quick transition from hot to

cool flow, speeding cleaning and reducing down time.

Smooth inner walls of Kimax Tempered Glass Pipe prevent scaling and corrosion. Since glass is inert, nothing is added or taken from the products flowing through this pipe . . . total assurance of constant product purity.

Transparency permits a rapid, visual check for stoppages. When clogging occurs, cleaning is quickly

and easily done since every joint is easily disassembled.

Light-weight, durable, and economical Kimax Tempered Glass Pipe is available with complete fittings and accessories for every piping requirement, and is interchangeable with other piping.

For your free copy of the current catalog, write to Kimble Glass Company, subsidiary of Owens-Illinois, Toledo 1, Ohio.

*Distributed in the U.S. and Canada by Fischer & Porter Company, Warminster, Pa.*

**KIMAX TEMPERED GLASS PIPE**

AN  **PRODUCT**

**OWENS-ILLINOIS**

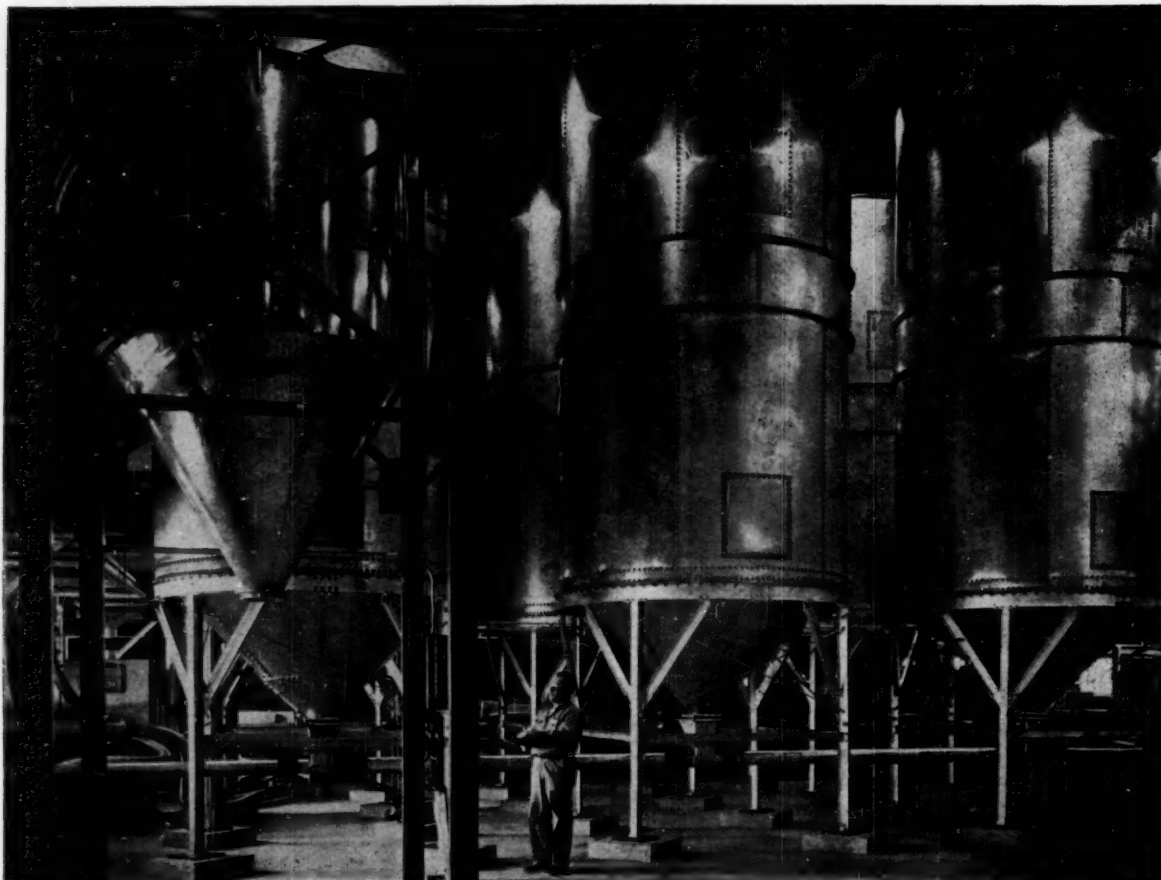
GENERAL OFFICES • TOLEDO 1, OHIO





# meet all bulk handling requirements

...with *Dracco Airstream Conveyors*



*Seven bulk handling jobs are performed by one Airstream Conveyor System at this eastern plastic film plant. In meeting all handling requirements, this versatile system provides what the company wants in:*

**handling flexibility**—Polyethylene pellets are unloaded from (1) hopper cars, (2) collapsible rubber bins, (3) bags . . . moved (4) to any storage bin, (5) directly to load-cell weigh bin, (6) from one bin to any other, or (7) from storage to process.

**lower materials costs**—Four per cent saving through bulk buying paid for Airstream System in less than three months.

**contamination-free handling**—Completely enclosed, self-cleaning system protects product purity, prevents intermixing of materials.

**operating economy**—One-man operation, low maintenance keep handling costs low.

**expandability**—Existing conveyor system can be expanded, at minimum engineering cost, to keep pace with plant enlargement and increased production needs.

• • • • •

These are the benefits gained by moving up to modern handling. Now it's your move! For the specialized help you'll need, call in: Dracco Division of Fuller Co., Harvard Ave. and East 116th St., Cleveland 5, Ohio.

See Chemical Engineering Catalog for details . . . or write for 32-page Bul. 530, "Dracco Airstream Conveyors".

# DRACCO

*airstream conveyors*  
dust control equipment



New from Du Pont: Protective Finishes Formulated  
Specifically to Combat Severe Corrosive Conditions

(T.M.)

# IMLAR

## Vinylmastic Coatings and Vinyl Enamels

DuPont announces a new line of chemical-resistant coatings to help you hold down spiralling maintenance costs by providing dependable, long-term protection under corrosive conditions that cause ordinary maintenance paints to fail rapidly.

### Ideal for Severe Acid Conditions

IMLAR Vinylmastic Coatings and Vinyl Enamels possess extraordinary resistance to spillage, fumes and vapors from highly corrosive acids and alkalies—including sulfuric and nitric acid, sodium chloride, ammonia and lime. They also withstand persistent condensate, water immersion and salt spray, have excellent resistance to radiation decontaminating solutions, are unaffected by surface temperatures up to 150° F.

### For Indoor or Outdoor Applications

Ready-mixed IMLAR coatings are recommended for field or maintenance painting of any steel or concrete surface subject to highly corrosive conditions. They can be used indoors as well as out, on buildings, structural steel, heavy machinery, bins, hoppers, tank or vat interiors and exteriors. Applied in three stages—primer, intermediate and topcoat—they dry quickly to a thick, hard, semi-gloss finish with excellent cohesion and flexibility, superior distensibility and abrasion resistance.

Relatively non-toxic, IMLAR coatings are easy to apply with conventional spraying equipment. Proper surface preparation (preferably sandblasting) is a must. Topcoats come in red or gray as well as black and white. Typical industrial applications for IMLAR include bleacheries, paper mills, chemical and petroleum plants.

For areas with severe alkali conditions, use new DuPont CORLAR<sup>(T.M.)</sup> Epoxy Chemical-Resistant Finishes. They offer excellent resistance to chemical fumes, spills and moisture.

For recommendations concerning your own specific corrosion problems, get the expert advice of your local DuPont Technical Representative. To reach him, call your nearest DuPont District Sales Office, listed in your phone book. For more detailed information about these new finishes, clip and mail the coupon below.

**Clip and Mail the Coupon Today  
for FREE Du Pont Technical Bulletin!**

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**IMLAR** <sup>(T.M.)</sup>  
Chemical-Resistant Coatings

**Better Things for Better Living . . . through Chemistry**



## Nobody's Guessing When Performance is Certified

Performance of a centrifugal pump, particularly of a self-priming type, can be greatly affected by small variations at critical internal points. The simplest as well as the most reliable check of such a pump is actual work.

That's why standard procedure at LaBour is an operating test of every pump before shipment, with a permanent record of performance as regards capacity, head, speed of prime, wet and dry vacuum, or other pertinent data de-

pending on the order. Of course, no LaBour pump can leave the factory unless it meets the customer's performance specifications, whatever they may be. The buyer of a LaBour pump may receive a certified transcript of its performance record.

Nobody ever guesses what a LaBour pump will do. All the facts are known before it is installed. If you want real assurance of pump adequacy and dependability, specify LaBour.

ORIGINAL MANUFACTURERS OF THE SELF PRIMING CENTRIFUGAL PUMP

# LABOUR

THE LABOUR COMPANY, INC. • ELKHART, INDIANA  
WHITE PIGEON, MICH. • LONDON, ENGLAND



# Maintenance and Steam Traps

... there's a relationship that goes far beyond trap maintenance alone

Good traps and good trapping have a greater effect on your maintenance costs than does trap maintenance itself. By that we mean that the right traps, properly selected and installed, and with the benefits of a preventive maintenance program, will save far more maintenance dollars than they will cost.

Under the pressure of spiralling maintenance costs, this thought becomes mighty important. Let's take a look at what it involves:

#### Proper Selection of Steam Traps

1. Be sure it's the right type of trap.
2. Be sure it's sized right and is for the correct operating pressure.
3. Be sure it's first rate in design and construction.

#### Proper Installation of Steam Traps

1. Install them so they are accessible for inspection and maintenance.
2. Install a test valve.
3. Use a union or unions.
4. Use a shutoff valve or valves.
5. Use a strainer ahead of the trap if dirt conditions are bad.
6. Use a by-pass only where continuity of service is imperative.
7. Standardize inlet and outlet connections.

#### Preventive Maintenance Program

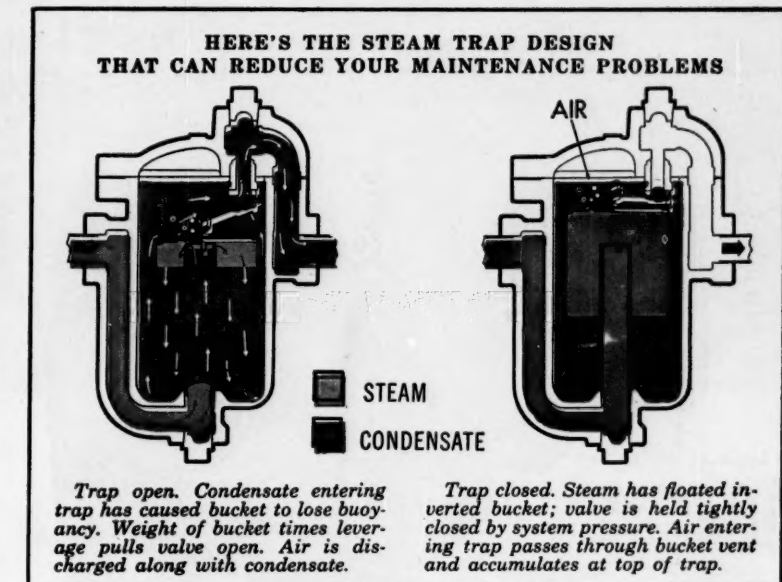
1. Test trap regularly for proper operation. (Trap size, operating pressure and importance determine frequency.)
2. Inspect internal mechanism at least once a year.

#### You Get Indirect Benefits As Well

The direct benefits of the plan outlined are pretty obvious — good traps, properly selected, require less maintenance... testing and inspection prevents troubles that lead to maintenance.

However, this plan provides indirect benefits which reduce maintenance in other parts of the plant as well:

**Good traps save steam and reduce the load (and consequently maintenance) on fuel handling and**



burning equipment and on ash handling equipment.

**Good traps protect the system** by eliminating water hammer and preventing the damage it can do.

**Good traps discharge carbon dioxide** before it can go into solution to form corrosive carbonic acid — less corrosion, less maintenance.

**Good traps increase production** to reduce the length of time equipment must operate or reduce the amount of equipment needed... either way maintenance is reduced.

#### How to Go About It (The Sales Pitch)

We admit we're prejudiced, but we don't think there is any better way to select steam traps than with the help of the 44 page Armstrong Steam Trap Book. Here in a single source is specific data on the selection and sizing of traps, how to install them for best results, and how to maintain them most economically.

The Steam Trap Book will also give you full information on the design and construction of Armstrong Inverted Bucket Steam Traps that offer these important maintenance-reducing advantages:

1. Armstrong Traps are dependable.

2. Armstrong Traps require no adjustments — go from full load to zero load automatically.

3. Armstrong Traps are self-scrubbing — ordinary dirt conditions can't hurt them.

4. Armstrong Traps have long-life parts — valve and seat are heat treated chrome steel — lever assembly and bucket are stainless steel.

5. Armstrong Traps have water sealed valves to minimize wire drawing and erosion.

Ask for your copy of the Steam Trap Book — there is no obligation. Then test Armstrong Trapping. If you are not completely satisfied with the results, you can return the traps for a full refund of the purchase price. You can't lose much that way. Call your local Armstrong Representative or Distributor, or write

**Armstrong Machine Works**  
8586 Maple Street  
Three Rivers, Michigan

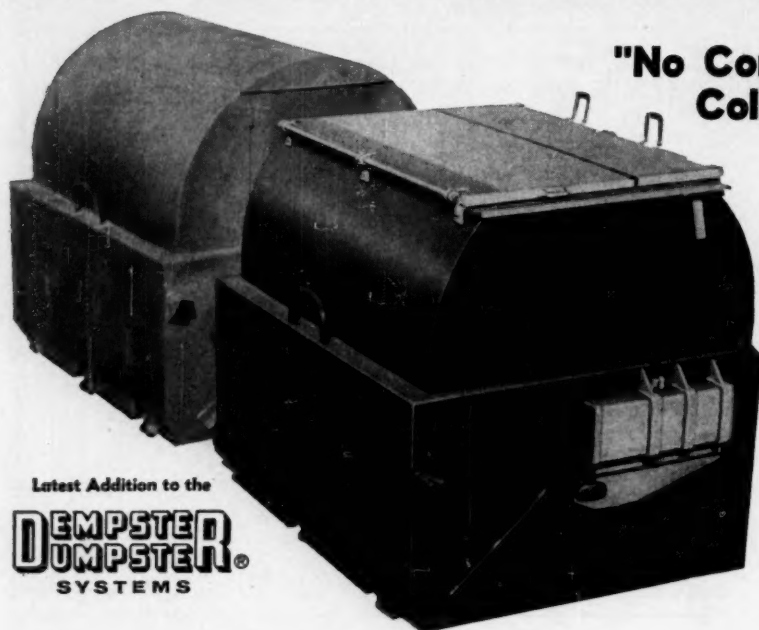


**ARMSTRONG  
STEAM TRAPS**

See our catalog in **CHEMICAL ENGINEERING CATALOG**



# New SUPER DUMPMASTER Handles Converted DUMPSTER Containers...Beats Long-Haul Problem



Latest Addition to the

**DEMPSTER  
DUMPSTER®**  
SYSTEMS

Owners of DEMPSTER-DUMPSTER Systems who now face long haul problems due to movement of disposal areas may now convert from their present "container haul" system to the new SUPER DUMPMASTER "no-container-haul" system without abandoning their investment in DUMPSTER Containers.

The SUPER DUMPMASTER makes its rounds to each converted container, mechanically empties the contents into its 30 cu. yd. packer body and compacts the material to a fraction of its former volume with the 85,000 lb. force of its packer plate. Rather than haul each container to the disposal area, the SUPER DUMPMASTER carries the contents of many containers on each trip, cutting collection costs drastically.

**Write Today for FREE BROCHURE**  
**DEMPSTER BROTHERS**  
Inc.  
**DEPT. CE-6, KNOXVILLE 17, TENN.**

## "No Container Haul System" Collects Refuse on Spot

If longer trips to disposal areas have raised your operating costs, a small investment in conversion kits protects large investments in DUMPSTER containers. The Super DUMPMASTER handles converted DUMPSTER containers up to 12 cu. yd. and all DUMPMASTER containers one thru 12 cu. yd.



Mfd. Only By  
**DEMPSTER BROTHERS**  
Inc.



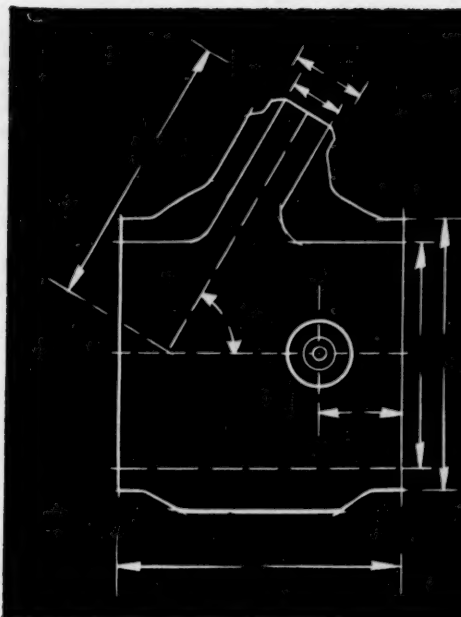
The SUPER DUMPMASTER engages container.



Clearance arms carry it toward hopper opening.

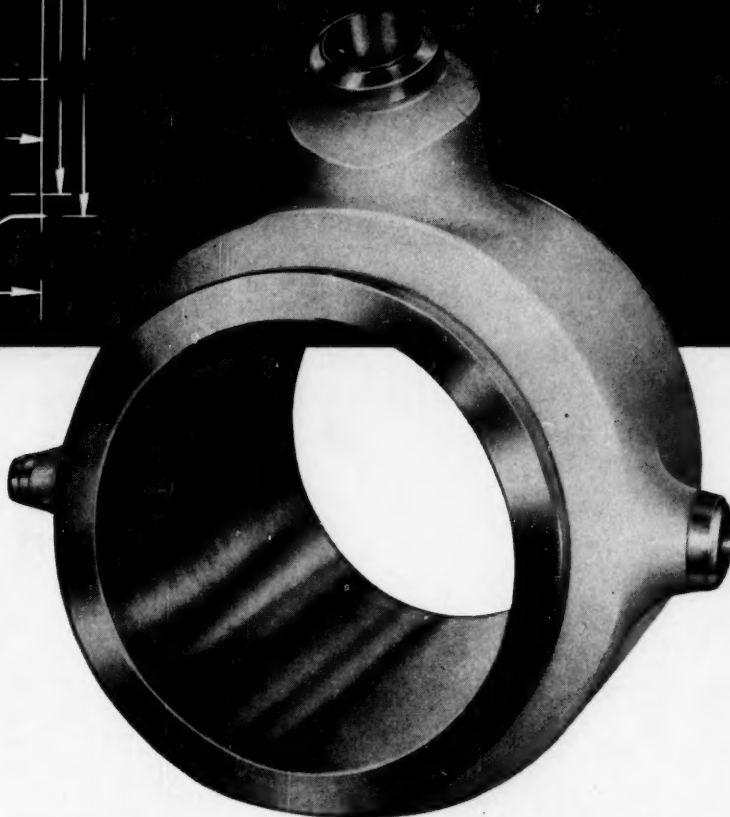


Container is rotated, emptying contents into the compaction body.



You specify it...

...we'll  
make  
it!



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Configurations can be the most simple or the most complex; metals can be carbon steel, stainless steel, Inconel, monel, hastelloy, aluminum or any other weldable metal; wall thicknesses can be up to 4" or more.

Midwest has an extraordinary aptitude for producing fittings of an unusual nature for unusual needs. With a thorough understanding of metals and their characteristics, and highly developed skills with forging presses, dies, and welding, Midwest can produce fittings in any materials, any shapes, any sizes.

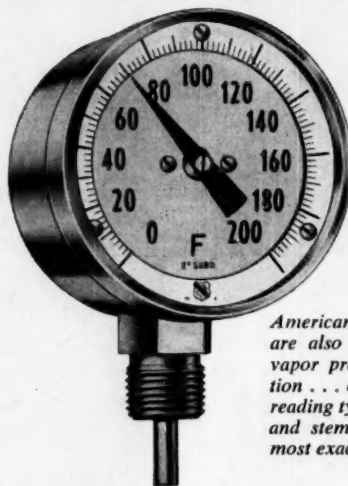
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# sharp

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*American Dial Thermometers are also available in mercury, vapor pressure, and gas actuation . . . on-the-spot and distant reading types . . . in sizes, ranges and stem lengths to meet your most exacting requirements.*

# sensitive

Any way you look at an American Bi-Metal Thermometer, you see exact working temperatures.

The two-level "Maxivision®" dial eliminates parallax effects. Numerals are on the lower level. Graduations are on the outer raised ring dial which presents a sheared edge to the tip of the pointer and in the same plane. To make readability even more accurate, the glass and graduated dial are closely spaced.

American Bi-Metal Thermometers are made of weather-proof stainless steel. All joints are

welded to solid unity, then polished smooth so corrosion won't build up and destroy the thermometer's usefulness. And, you don't have to discard this thermometer even if the glass is ever broken. The bayonet lock bezel makes replacement easy.

Learn about the high sustained accuracy and long service life built into American Bi-Metal Thermometers. Phone your nearby industrial supply distributor for help in selecting the right type for each temperature check point in your plant. Or write for Catalog 155.



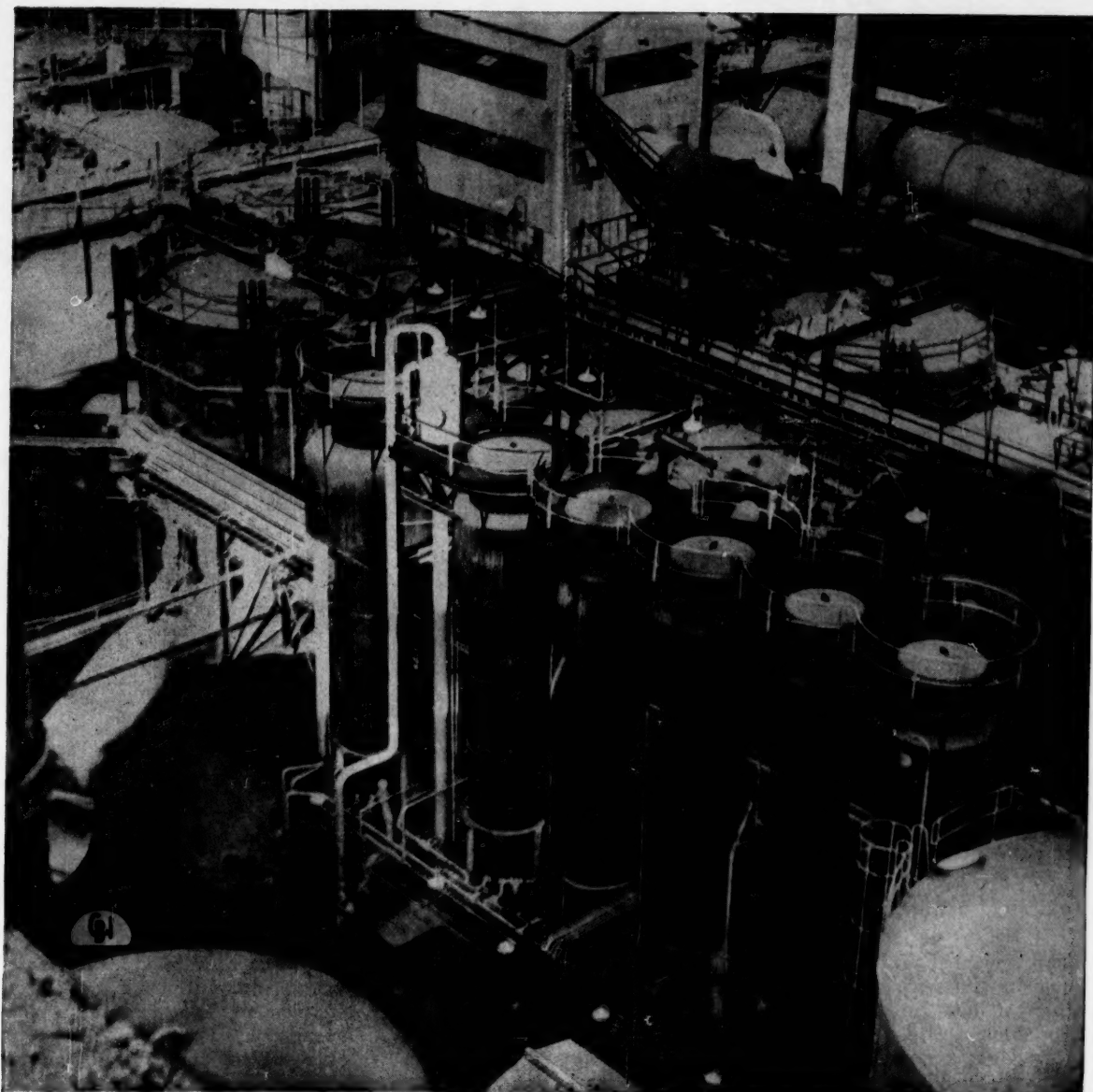
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Recovering more than 99.9% of the process chemicals and collecting waste heat, with low-pressure exhaust steam, are the remarkable, highly efficient accomplishments of this CB&I-designed sextuple effect evaporator.

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cover all but a minute quantity of the processing chemicals.

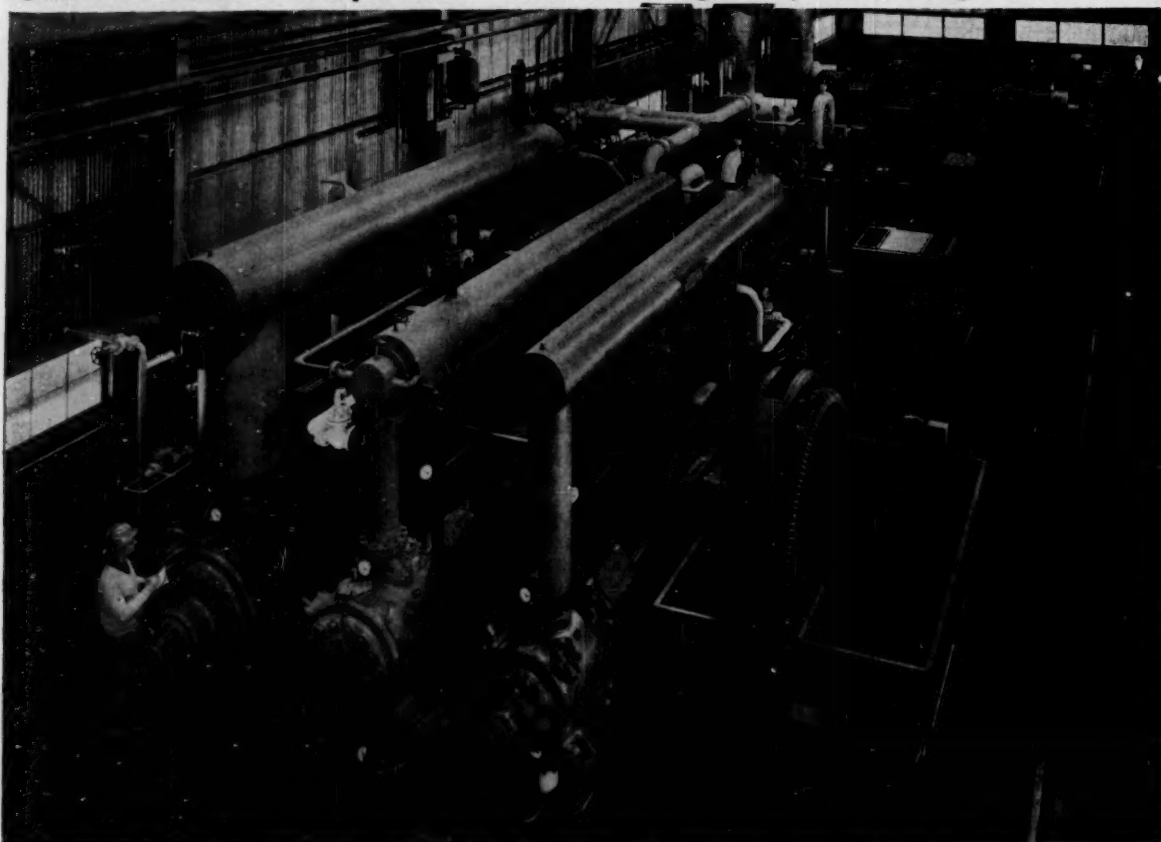
To get full details today, write Chicago Bridge & Iron Co., 332 South Michigan Ave., Chicago 4, Ill. Offices and subsidiaries throughout the world.

CB&I



# OVER 3000 HOURS ON STREAM...

Clark non-lube compressor still has original piston rings and trim!



Foreground—Clark Non-Lube Model CRA Balanced/Opposed Compressor in an air separation plant.

Uncontaminated nitrogen gas for a liquid oxygen refrigeration cycle is kept "bone dry" in this Clark Non-Lube Model CRA-6 Balanced/Opposed Compressor. Installed in Wheeling Steel's new air separation plant at Steubenville, Ohio, the 1250 bhp unit has shown remarkable dependability since startup. After going through initial blowdown, initial startup, and 3000 hours on stream, the machine is still operating with its first set of piston rings and trim.

There are several reasons for this on-the-job endurance:

- The compressor operates at a conservative speed to hold down friction and temperature levels.
- Staging is extremely conserva-

tive—five stages are used to compress nitrogen from atmosphere to 565 psi.

- Non-lubricated, non-metallic piston rings, packing rings and riders are used to prevent hydrocarbon contamination of the gas stream.

- Compressor piston rods and cylinder liners are micro-polished to minimize wear and heat of friction.

- The non-lube cylinders are connected to the crankcase by extra long distance pieces. Lubricated areas of the piston rod do not enter the non-lubricated cylinder.

- Clark Balanced/Opposed design provides smooth, vibration-free performance. The foundation need only be large enough to support the weight of the compressor.

Unit was furnished as a complete package with overhung motor, all intercoolers and interconnecting piping mounted on the compressor frame.

The new tonnage oxygen plant at Wheeling Steel is just one of many modern processes where Clark Balanced/Opposed Compressors have been specified because they can do the job best.

Air or gas, lube or non-lube, 75 to 8000 bhp, vacuum to 50,000 psi . . . Clark has the compressor—and the experience—to help you make the most profitable choice. The next time you plan a new facility, take advantage of them both. Contact your nearest Clark representative first!

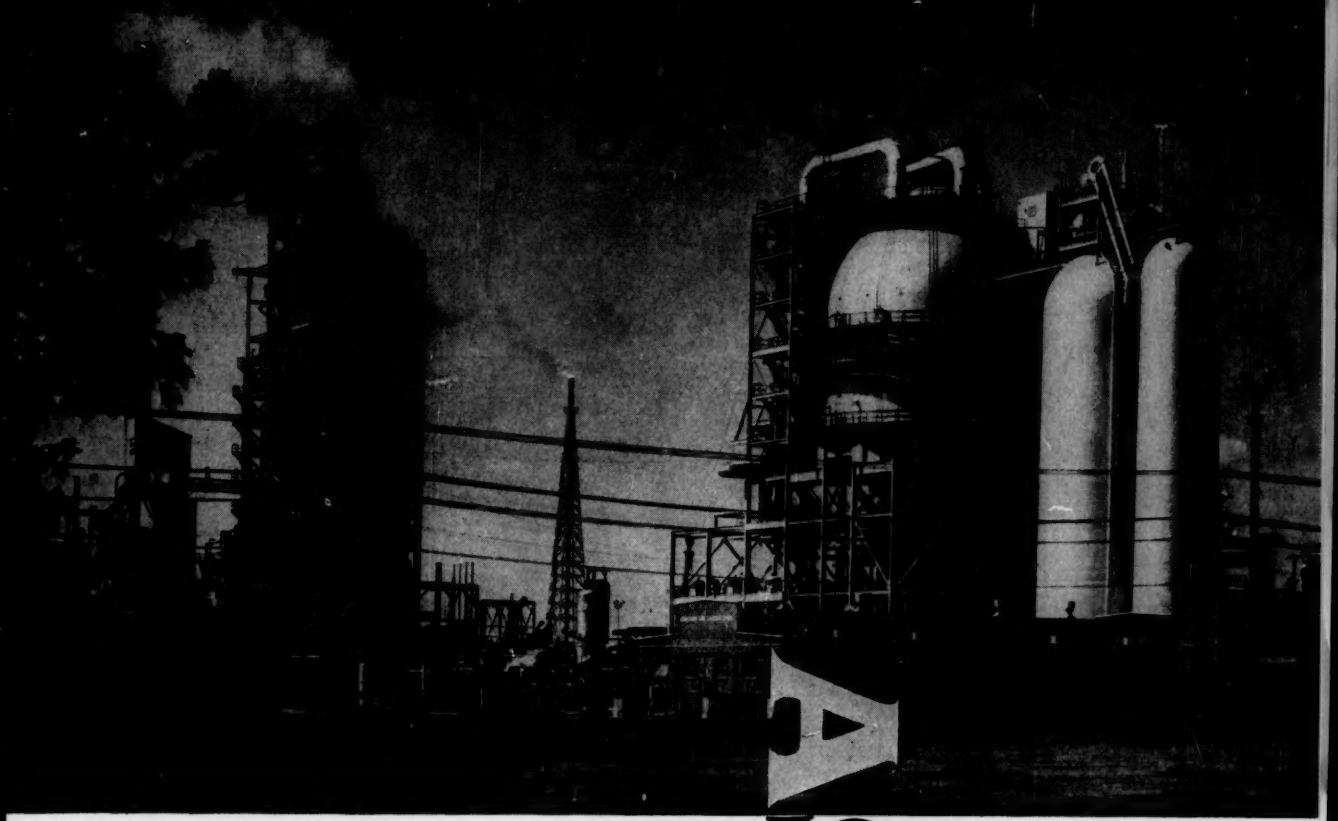
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resistance to corrosion:*

**FEDERATED CHEMICAL LEAD  
sheet, pipe, fittings, linings**

Federated lead products are self-healing; malleable, easy to form and bend; salvable with high scrap value; and probably the most efficient protection you can find for many corrosive chemical conditions. These products include chemical lead sheets to your requirements; pipe, bends, traps and standard fittings available from stock; special forms fabricated to order. Write for Bulletin No. 162, the Lead Handbook for the Chemical Process Industries, to Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, RE 2-9500; or call your nearest Federated sales office.

AMERICAN SMELTING AND REFINING COMPANY

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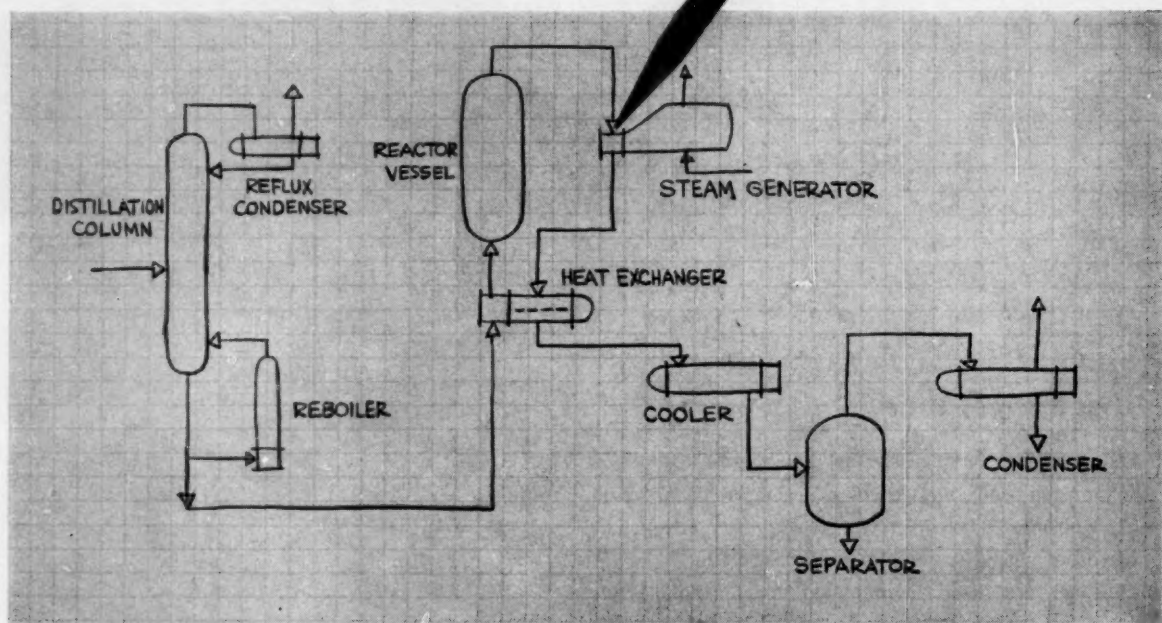
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when you plan  
your process...

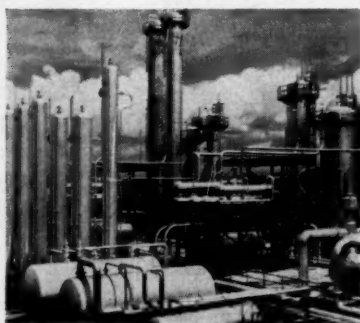
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Plan on A. O. Smith for your process equipment—and plan with confidence. A. O. Smith has the facilities and know-how to custom-tailor process equipment to your exact specifications. A world-recognized leader in the process equipment field, A. O. Smith can provide quality-built components to satisfy any process requirement.

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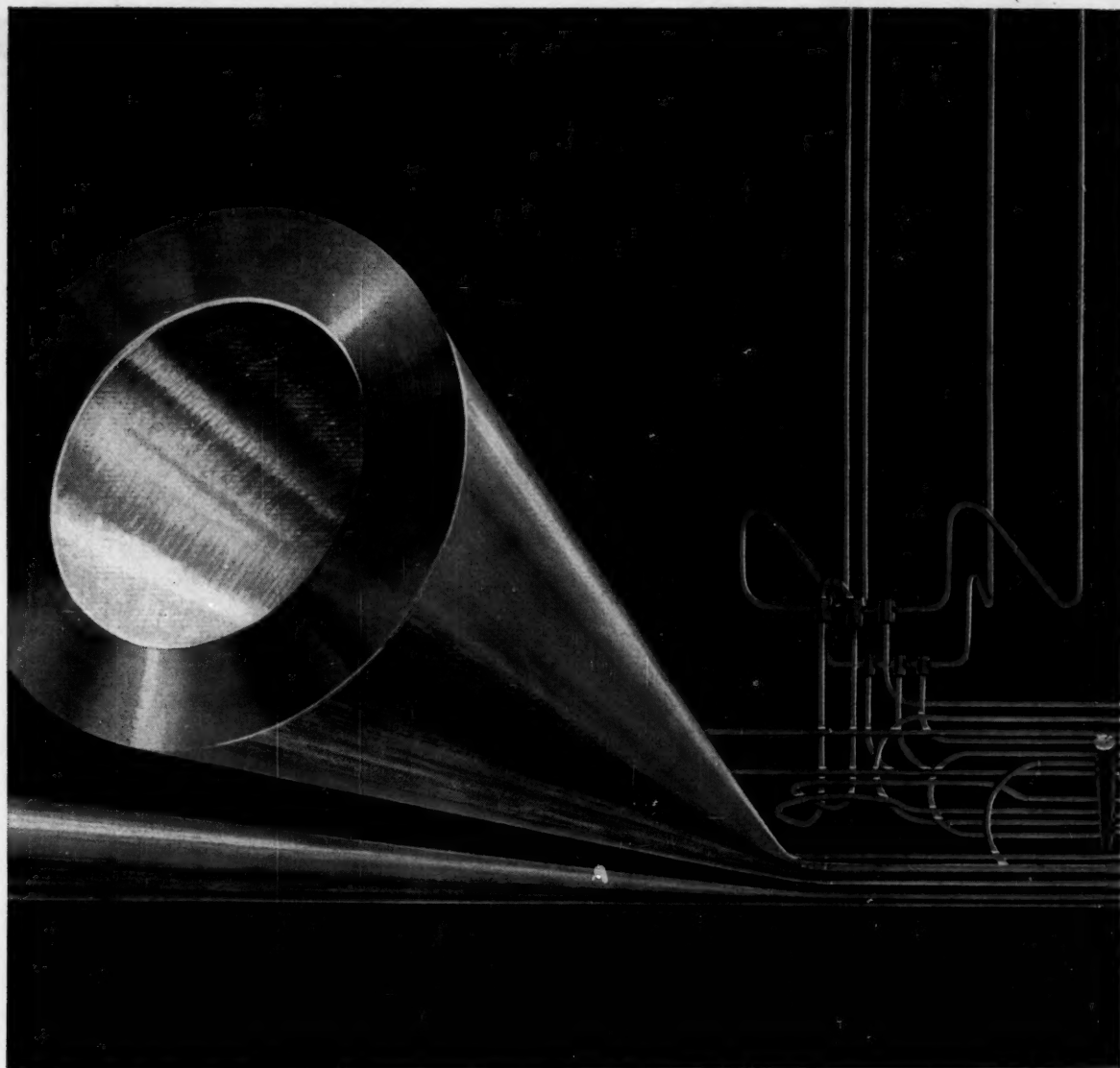
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EQUIPMENT DIVISION**  
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## **How to handle super critical steam at 100 m.p.h.**

Today's modern power generating plants demand superheater tubes and piping that must meet the highest pressure-temperature combinations ever achieved with steam. The Timken Company is supplying these tubes—stainless steel pressure tubes. In fact, we've produced tubes made from a special steel never before successfully pierced—until our experts did it.

Timken® stainless steel pressure tubes are the answer to many high temperature-pressure problems be-

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Let Timken Company metallurgists help you solve your tough steel problems. They're acknowledged experts in their fields. They'll work with you to select the stainless steel pressure tube to suit your needs and give you your money's worth.

Call or write: The Timken Roller Bearing Company, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

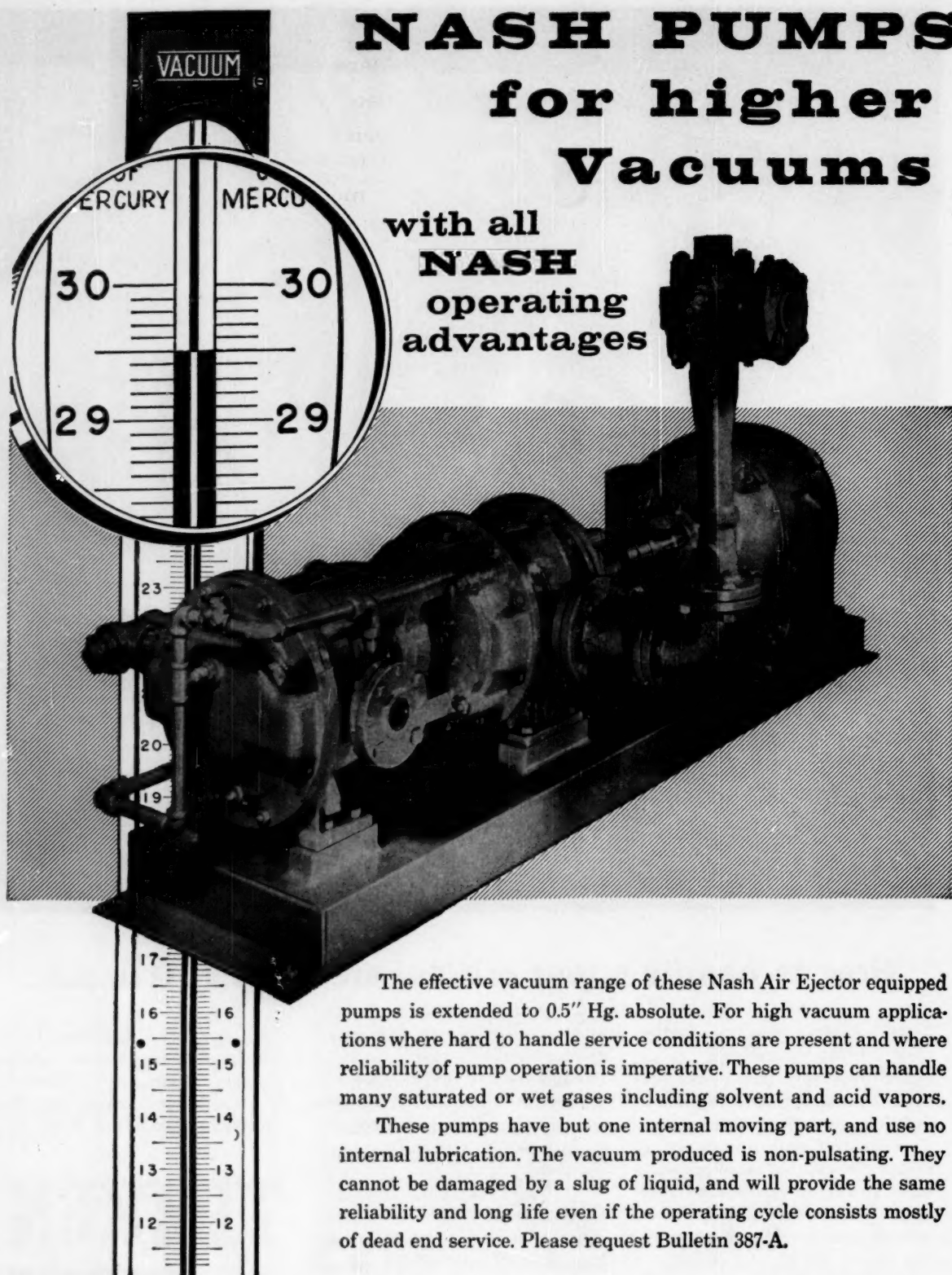
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# NASH PUMPS for higher Vacuums

with all  
**NASH**  
operating  
advantages



The effective vacuum range of these Nash Air Ejector equipped pumps is extended to 0.5" Hg. absolute. For high vacuum applications where hard to handle service conditions are present and where reliability of pump operation is imperative. These pumps can handle many saturated or wet gases including solvent and acid vapors.

These pumps have but one internal moving part, and use no internal lubrication. The vacuum produced is non-pulsating. They cannot be damaged by a slug of liquid, and will provide the same reliability and long life even if the operating cycle consists mostly of dead end service. Please request Bulletin 387-A.

**NASH ENGINEERING COMPANY**  
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The New Bulletin 709

PLUS VALUES OF THESE NEW STARTERS

Greatest  
advance  
in motor  
control  
in 30  
years

- smaller size
- greater interrupting capacity
- even more millions of trouble free operations
- more wiring room
- elegant styling
- A-B "quality" throughout



a complete new line of Bulletin 709 motor starters

Thirty years of experience have gone into the design of this new Allen-Bradley line of motor starters. While retaining the simple solenoid principle—with only ONE moving part—these Bulletin 709 starters are *completely new in every way.*

They are amazingly smaller—especially in the higher ratings. Yet test after test proved they will outlast any starter now on the market *by many times!*

The new, patented, high-efficiency magnet—remarkably powerful for its size and weight—is cushioned to reduce shock and wear. The new molded coils are pro-

tected against damage and harmful atmospheres. The new, precision hot molded arc hoods confine the arc and increase interrupting capacity.

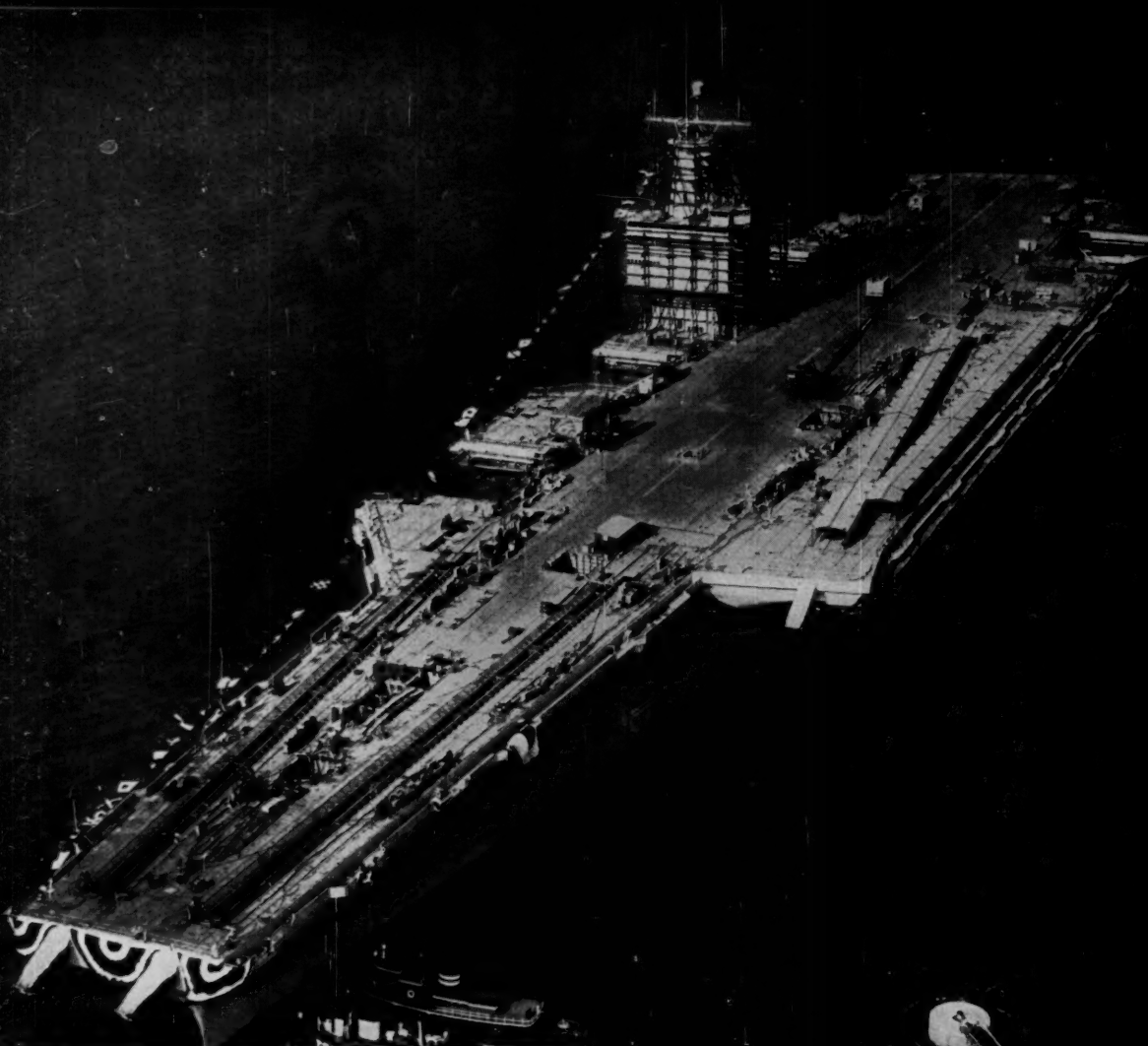
New weld-resistant, cadmium oxide silver contacts close and seat firmly—without wear-causing motion. The new overload relays are not only *trip-free* but also *tamperproof*—but the "heaters" remain unchanged. The smart, new cabinets—by Brooks Stevens—are an asset on any type of installation. Better write for full details on this revolutionary new "family" of Bulletin 709 *quality* motor starters.

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Member of NEMA

Allen-Bradley Co., 1337 S. First St., Milwaukee 4, Wis.

*Quality  
Motor Control*




## giant guardian...

Four football fields could be laid out on the flight deck of the giant, nuclear-powered U.S.S. Enterprise—the world's largest ship. But size isn't the only dimension that makes the Enterprise outstanding. Pressurized water nuclear reactors, producing over 200,000 horsepower, will drive her at speeds in excess of 25 knots. She will be able to sail the seven seas for several years without refueling.

Carlson corrosion and heat-resistant stainless steel plate was used in this huge Attack Aircraft Carrier, and in her nuclear power plant. The builders of the Enterprise have confidence in the stainless plate produced by Carlson specialists. Exacting quality standards and dependable delivery result from such specialization.

Whether you are building a gigantic ship, a nuclear power plant, or corrosion-resistant process equipment, we can help you make it best. For practical assistance in filling your requirements for stainless plate in a wide range of grades and sizes, contact Carlson.

Our new booklet, "Producing Stainless Steels . . . Exclusively," is available. Write for your copy now.



Photograph of the launching of the U.S.S. Enterprise.  
Courtesy of Newport News Shipbuilding & Dry Dock Co.

OFFICIAL U.S. NAVAL PHOTOGRAPH

## G.O. CARLSON Inc.

*Producers of Stainless Steel*

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THORNDALE, PENNSYLVANIA  
District Sales Offices in Principal Cities

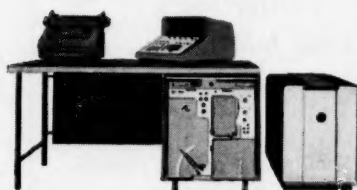


Plates • Plate Products • Heads • Rings • Circles • Flanges • Forgings • Bars and Sheets (No. 1 Finish)



# ANOTHER IN THE CAUTIONARY SERIES ABOUT RECOMP II [in which we reveal nearly all the computer's subtle enticements]

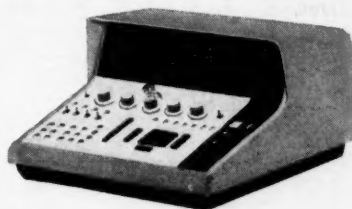
Here, for the very first time, is an unpurgated listing of the allurements of Recomp II. They are potent. They are persuasive. They are enticing. Indeed, in reading them it would be wise to exercise a decent restraint... for you may find yourself falling in love with a computer:



- 1] The first solid-state digital computer on the market was Recomp II. The finest computer on the market is still Recomp II. Recomp II's dedicated engineers are determined that the situation shall remain this way; they have an obsessive regard for this precise machine they have so carefully developed.
- 2] Recomp II is the only compact computer with built-in floating point arithmetic. It defies being hemmed in on a problem. With its large capacity it obviates computer-claustrophobia.
- 3] Always the darling of the medium-scale computer user, Recomp II has been so well accepted that it can now be offered at a *significantly lower price*. It still provides the identical quality, solid-state performance, and features that can't be found on computers costing three times what Recomp II used to cost.
- 4] Recomp's memory, employing the new optional Recomp Magnetic Tape Transport units, would stagger an elephant. Each unit has a memory of over 600,000 words. Up to eight of these transport units can be connected to Recomp II, giving you a computer with a total memory capacity of over 5,000,000 words. Remarkable!
- 5] The speed of the new magnetic tape

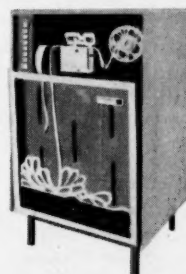
control described above is quite remarkable, too. Read and write speed is 1850 characters a second; bidirectional search speed is 55 inches per second.

- 6] Always the darling of the medium-scale computer user, Recomp II has been so well accepted that it can now be offered at a *significantly lower price*. It still provides the identical quality, solid state performance, etc.
- 7] Recomp II seems to have more built-in features than a dream-home kitchen. It has built-in square root command. Built-in automatic conversion from decimal to binary.
- 8] Would you say that a RUG is important to a computer? Well, it is. The RUG we mean is Recomp Users Group. This is a highly active group, sharing up-to-date information, and keeping in close contact by monthly bulletins. A consideration not to be overlooked when buying a computer.
- 9] Always the darling of the medium-scale computer user, Recomp II has been so well accepted that it can now be offered at a *significantly lower price*. It still provides, etc., etc.



- 10] Recomp's keyboard, which you can see above, looks easy to operate. It is. And because it requires no specialized talents, anyone with computer problems can be taught to use Recomp II. Quite a handy machine to have around.
- 11] Recomp II can easily be installed anywhere, requiring no more electricity than an ordinary electric toaster.
- 12] Another new optional feature for

your Recomp II is the Facitape tape punch and reader console, shown below. It punches 150 characters a second, reads 600 characters a second, and stops on a character. It adjusts to read and punch from 5 through 8 channels. Quite uncanny.



- 13] A visual readout on the control panel allows you to check any information about to be entered into Recomp II before you press the "enter" button. The information can be corrected easily if necessary. This is further evidence of Recomp II's staunch adherence to efficiency.
- 14] Recomp II's programming is highly efficient. It has 49 basic instructions, expandable to 72. Word length is 40 binary bits; very large, indeed.
- 15] Always the darling of the medium-scale computer user, etc., etc., etc.
- 16] Recomp II has a large sub-routine and program library, and a large program exchange.
- 17] Each word programmed into Recomp II contains two instructions.

Recomp II has many other features, but as you can see, space is running short. We would have liked to have lingered upon the details of Recomp II's own full scale compiler called SALT, and even maybe discuss the high-speed loops a little... but. Perhaps, if you are beginning to feel the stirrings of your acquisitive instinct toward Recomp II, you should see it in action. We can arrange a demonstration for you through our local offices in New York, Chicago, Boston, San Francisco, and Long Beach. Or, at the very least write for more information. We have some nice brochures you will enjoy reading.

Write AUTONETICS INDUSTRIAL PRODUCTS, Dept. 066, 3400 E. 70th St., Long Beach, Calif.  
The Autonetics Division of North American Aviation.





## THE QUESTION:

"We are operating at a reflux ratio of 1:1 with a vapor velocity of 4 feet per second. The system is acetone and water. Packed depth is 30' of porcelain raschig rings. How many more transfer units can I get if I switch from 1" raschig rings to Intalox saddles?"



This question is typical of those which can be answered by referring to the data appearing in U. S. Stoneware's Engineering Manual on Packed Towers . . . data reflecting the results obtained from our continuing research into the mechanics of packed tower operations, conducted in our experimental towers in our laboratories in Akron.

## THE ANSWER:

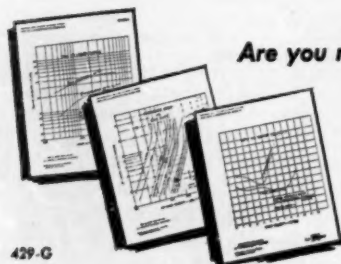
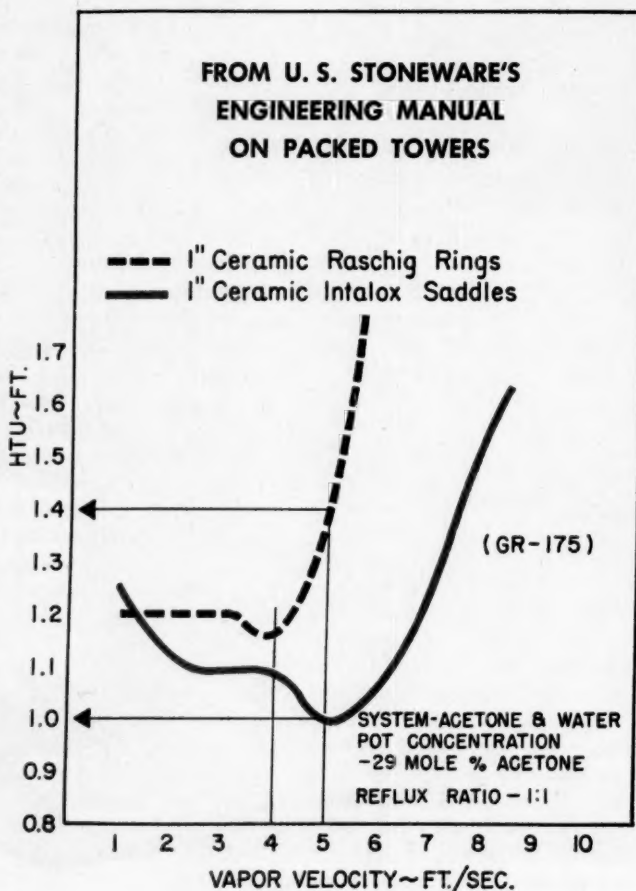
The curves in the chart at the right reflect the performance of 1" ceramic raschig rings and 1" ceramic Intalox® Saddles in a series of test runs in our experimental towers with the system: Acetone and water.

As you will note, the lowest HTU for raschig rings (about 1.17 ft) is developed at the 4' per second velocity specified in the question. While the HTU for Intalox Saddles at the same vapor velocity is somewhat lower (1.10 ft), the difference is hardly enough to warrant the higher cost of Intalox Saddles.

However, at 4' per second, the raschig ring packed tower is operating dangerously close to flooding as evidenced by the rapid increase in HTU with only a slight increase in vapor velocity. Practically, vapor velocity should be held between 3' and 3½' per second for an HTU of approximately 1.2'.

But, a changeover from ceramic raschig rings\* to ceramic Intalox Saddles would do this: it would permit an increase in vapor velocity to 5' per second for an HTU of 1 foot. This would mean a 20% increase in the number of transfer units and a profitable 30% increase in operating capacity.

\*Whether the change is made or not, it would be best to split the 30' bed into two 15' beds to obtain optimum performance.



### Are you receiving these reports?

We'll be glad to place your name on our list to receive these reports on packed tower performance as they are released. Write, on your letterhead, Engineering Dept., U. S. Stoneware, Akron 9, Ohio.



---

## Chementator

### Surplus corn now looms as factor in industrial alcohol production

Negotiations are now going on between the Dept. of Agriculture and Publicker Industries, Philadelphia, to settle the terms of a contract involving sale of some of the nation's surplus corn for use in making industrial alcohol.

Agriculture Dept. has said it is willing to sell limited amounts of corn to lessen the dependency on imported molasses for fermentation processes. Publicker had intended to buy 120 million gal. of molasses from Cuba, but has been prevented from doing so by the trade embargo.

At issue between the company and the department is the wording of a renegotiation clause relating to the price of the corn. The department expects that the sale will bring howls of protest from producers of petrochemical alcohol and so wants to protect itself from criticism by iron-clad guarantees in the contract, to prevent excess profits.

Sale would work like this: the department will make available 15 million bushels during the next 12 months. (It would take about 30 million bu. to be equivalent to 120 million gal. of molasses.) Price for the corn will probably be under 75¢/bu.—which is half of the present farm-support price. However, the renegotiation clause will provide for an increase in price, to limit the buyer's profits, if such a change appears necessary.

---

### Huge fluid-bed phthalic plant delights petronaphthalene makers

As an outgrowth of the recent shortage of phthalic anhydride (caused in turn by the naphthalene shortage), Union Carbide Chemicals is going to build a 50-million-lb./yr. phthalic plant at Institute, W. Va.

This is Carbide's first move into phthalic production, and it means that a big phthalic consumer will be disappearing from the market. Coming at a time when it's estimated that 30%

of the phthalic capacity is idle, the firm's move could cause a downward pressure on prices. A Carbide spokesman says that he anticipates "a sharp drop" (it's now at 20¢/lb.) but declares that the payout still looks good for the new unit.

The firm will have captive use for much of the output in its line of plasticizers for polyvinyl chloride. It also has a long-term contract to supply Food Machinery & Chemical (as of July 1: FMC Corp.) at South Charleston, W. Va.

To be engineered by Badger Mfg. Co., the plant represents another victory for the proponents of the fluid-bed route. Monsanto Chemical, which is building a phthalic plant in Gloucester County, N. J., has also gone over to fluid bed.

Fluid-bed phthalic plants are ideal customers for petrochemical naphthalene since they require high-purity feed. Although naphthalene is still in tight supply, by the time the Carbide plant comes on stream in late 1962, it will be able to draw on nearby petronaphthalene plants of Ashland Oil, Tidewater-Collier, and Sun Oil.

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### Gulf Coast petrochemical complex will set trend in process control

Monsanto Chemical Co., whose first application of closed-loop digital-computer control made headlines last fall (*Chem. Eng.*, Nov. 14, 1960, p. 110) has made a new move in this field. It has just ordered four control computers for its Chocolate Bayou, Tex., petrochemical project.

Minneapolis-Honeywell has landed the contract for both the electronic instrumentation and the computers. To do so, it bettered bids by firms such as TRW Computers Co., IBM, and Daystrom (which evidently has withdrawn from the field).

More than one precedent is being set by Monsanto's latest computer application:

- Plant complex is being designed from ground up for computer control. This means that unlike previous installations the project won't require expensive instrument modification to adapt to computer control.

- Electronic instruments will eliminate need



Gas chromatography does complex solvent analyses in minutes. Here, a Shell chemist prepares a sample for injection.

## **BULLETIN:**

**Shell Chemical announces a monograph describing 31 tests—some standard, some ingeniously devised—to give you greater insight into surface coatings.**

Shell uses these 31 tests as a backbone in lacquer formulation. They have led to startling concepts such as *the advantages of solvent retention* and to remarkable new high boiling solvents such as Pent-Oxone\* *keto-ether* and Pent-Oxol\* glycol ether.

Read how you can get an indexed, 60-page copy of this monograph telling how to set up these 31 tests, how to run them and *how they can help improve your current formulations.*

**T**HE 31 tests used regularly at Shell Chemical's Technical Service Laboratory in Union, N. J. have led to some fascinating new fields of investigation. One is solvent retention.

### **A twist on solvent retention**

While slow solvent release is known

to cause film shrinkage and have a bad effect on print resistance, *retained* solvent has recently been found to have *good* effects on gloss retention and restoration, cold crack resistance and weatherability.

Test 29 can help you study these dual effects in terms of *what actually happens when lacquer dries.*

### **Two remarkable new high boilers**

Studies of this type led directly to Shell Chemical's two remarkable new high boilers: Pent-Oxone *keto-ether*, particularly promising in formulations with *dissimilar resins* and Pent-Oxol glycol ether for *maximum blush resistance/practical drying time* in nitrocellulose lacquer formulations.

### **How to get your monograph**

To get your monograph, write or call any of the 9 district offices of Shell's Industrial Chemicals Division. Or

write Shell Chemical Co., 110 W. 51 Street, New York 20, N. Y.

#### **Samples and information**

When writing for a copy of the monograph, ask for samples and information on any of these items:

Acetone	Isopropyl Ether
Bisphenol-A	Mesityl Oxide
Diacetone Alcohol	Methyl Amyl Acetate
Di-tertiary-butyl peroxide	Methyl Ethyl Ketone
Ethyl Alcohol	Methyl Isobutyl Carbinol
Ethyl Amyl Ketone	Methyl Isobutyl Ketone
Glycerine	Neosol® Solvent
Hexylene Glycol	Pent-Oxone* Keto-ether
Isopropyl Alcohol	Pent-Oxol* Glycol Ether
	Secondary Butyl Alcohol

\*Trademark, Shell Chemical Company

A Bulletin from  
**Shell  
Chemical  
Company**



Industrial Chemicals Division

to transduce measurement and control signals between computer and controllers.

•Computers will have magnetic-core elements for the working memory, backed up by drum memory for permanent program storage. Present computer installations use slower drum memory only.

•Use of four computers suggests that application will take control concepts further than before. One possibility: three of the computers may be used to supervise control of three plant units, with the fourth used to set the optimum economic performance of the three units.

Though the firm hasn't revealed which process units will be computer-controlled, it's a good bet that the 500-million-lb./yr. ethylene plant will be one of them. Other possibilities are benzene, naphthalene and phenol.

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*Suntide Refining Co. will build a 15-million-lb./yr. p-xylene unit at its Corpus Christi, Tex., refinery. Process will be Phillips Petroleum's low-temperature fractional crystallization route with continuous pulsating column (Chem. Eng., Dec. 1955, pp. 128-132), currently used in the U.S. only by Cosden Petroleum at Big Spring, Tex.*

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## Uranium price-cuts nudge atomic power closer to economic levels

Recent reductions in the price of enriched uranium by the AEC have U.S. reactor manufacturers refiguring their costs.

AEC reduced prices on a sliding scale of 34% for 1% enrichment, to 20% for fully enriched uranium. At the same time, the use-charge was raised from 4% to 4.75% per year. (AEC only leases enriched uranium; the material cannot be purchased.) Besides savings in lease charges, the lower base prices also apply to the uranium consumed by the lessee, which must be paid for.

Effect of these price-cuts in actual power generating will vary from reactor to reactor. Commission experts estimate the reductions will range from 0.3 to 0.6 mills/kwh. Total cost of atomic power generation is now 11.5 to 17 mills/kwh.

The level at which nuclear power in the U. S. might begin to compete with power from coal, gas or oil is 7-9 mills/kwh. This threshold is set by conventional utility plants in high-cost fuel areas such as Florida, the Northwest and the Northeast.

AEC also states that it is considering asking Congress to amend the 1945 Atomic Energy Act to permit private ownership of enriched uranium. This would eliminate the government's solitary role in uranium price setting. And with the drop in price of unenriched uranium yellow cake on the world market (some lots have gone for less than \$5/lb., while AEC pays \$8/lb.), this could lead to use of gas centrifuges for enriching outside of AEC plants.

---

*Great Lakes Steel Corp. has ordered a computer system from TRW Computers Co. to provide open-loop control of two 300-ton/day basic oxygen steel furnaces being installed at its Detroit mill. These are believed to be the first furnaces designed for computer control, although Jones & Laughlin is experimenting along similar lines.*

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## Chemical extraction process opens up a major U. S. beryllium source

In a bid to remove the stigma of scarcity from beryllium, United Technical Industries, Murray, Utah, and Beryllium Corp., Reading, Pa., have launched a joint \$1-million venture to produce beryllium oxide from large domestic reserves at Delta, Utah.

Construction on the Delta plant is well under way and it is expected to come on stream in a few months. Design capacity is 25-30,000 lb./mo. of BeO, enough to provide about 20% of Berylco's current needs.

This venture will mean a big change in beryllium technology. Both Beryllium Corp.'s and Brush Beryllium's metal reduction plants now start with imported beryl ore that contains only 10% BeO. Not only does the Delta plant end dependence on foreign ores, but it will also provide a 97% BeO product that will eliminate several concentration steps at the reduction plant.

(Continued on page 56)



*Now... a new answer to a wide*  
**The D-O WEBTROL™**

*With fully automatic and continuous  
belt tracking system, providing  
the ultimate in web control*

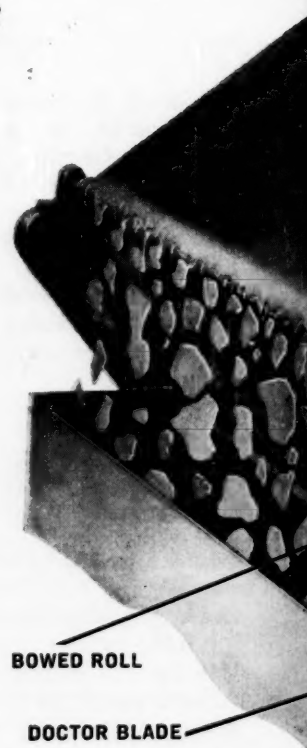
Developed out of the long experience of the Dorr-Oliver organization in building all types of filtration equipment, the new D-O Webtrol Filter provides a new opportunity for efficient handling of many problems not readily solved with conventional units.

It is particularly applicable where slurries with low solids content are handled, where cloth blinding is a problem and where desired filtrate clarity is not obtainable with usual types of vacuum drum filters. In many cases it can be used effectively where a pre-coat filter would normally be considered. Advantages are high capacity maintained over extended periods of use, simplicity of operation and superior washing ability.

The D-O Webtrol Filter combines the basic principle of the Oliver vacuum drum filter with a soundly engineered, automatically controlled roll and tracking system.

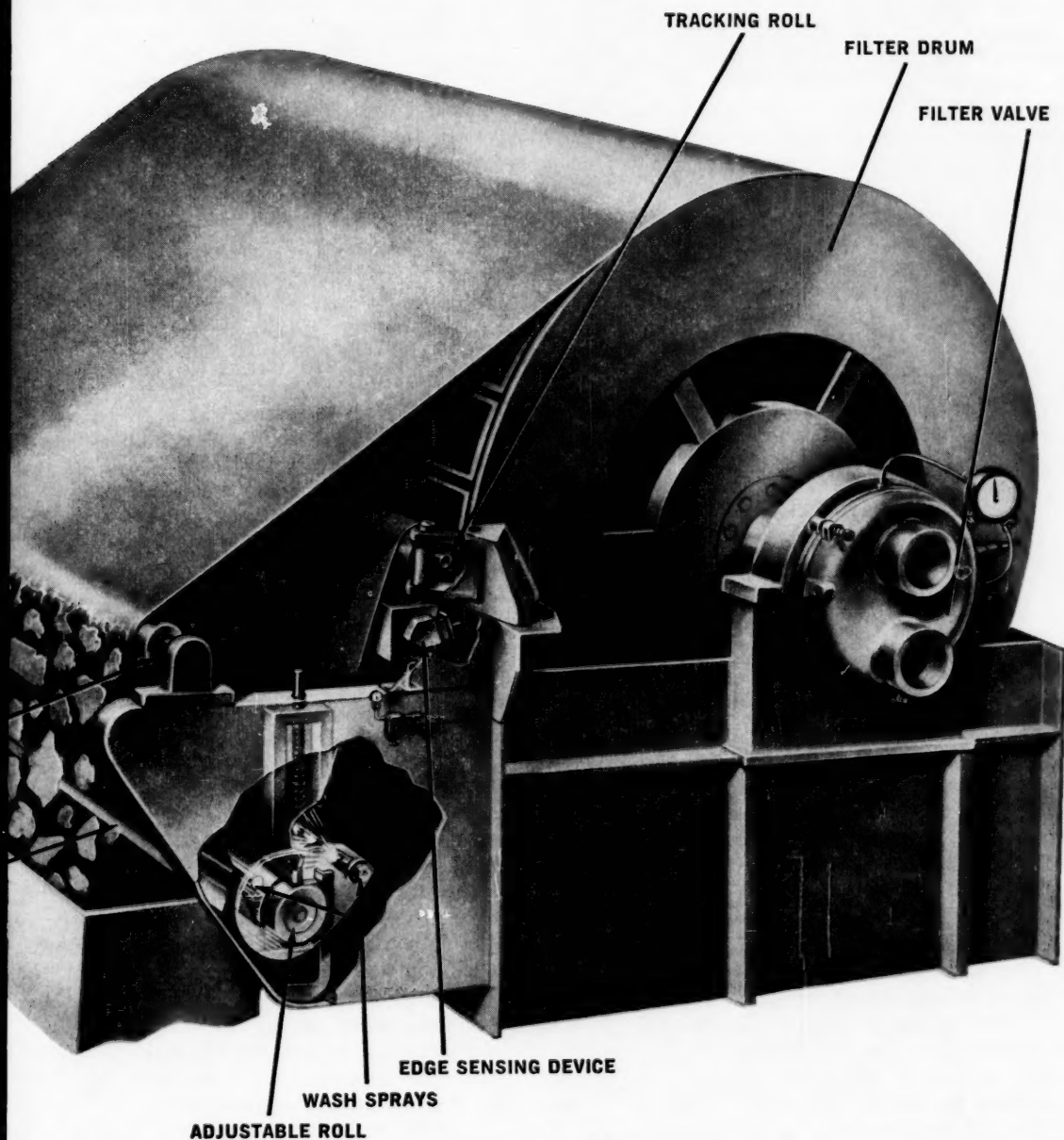
In most cases, dry cake falls automatically off the bowed discharge roll. A doctor blade, wire scraper or sluice nozzles may be used where required. An external wash system using high velocity jet sprays minimizes blinding and permits use of a closer weave cloth for greater filtrate clarity. A wide variety of cloth may be used, depending on slurry characteristics.

For full information, write for Bulletin #7203 to Dorr-Oliver Incorporated, Stamford, Connecticut.



*range of filtration problems*

# Belt-Type Filter



 **DORR-OLIVER**  
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

According to Walter R. Lowry, Beryllium Corp. president, process starts with a sulfuric acid leach that puts the beryllium—and many impurities—into solution. The separation steps are described only as “purely chemical,” and don’t involve flotation, solvent extraction or ion exchange. Beryllium is recovered through use of one proprietary reagent and six common chemicals.

Since the process consumes large amounts of acid, Allied’s General Chemical Div. is known to be considering building a sulfuric acid plant at Delta. Another firm, Vitro Minerals, is also experimenting with acid-leaching of the Delta ore, but is thought to be using ion-exchange to win beryllium from solution (*Chementator*, May 1, p. 32).

Beryllium Resources, Inc., also plans to build a mill at Delta to produce a 7% BeO concentrate via its Van Dornick flotation process.

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*An electrodialysis process for converting brackish water to fresh is being offered by Aqua-Chem, Inc., Waukesha, Wis. Licensed from a Netherlands research firm (Chementator, Jan. 27, 1958, p. 58), process is now desalting brackish water in a 2.8-million-gal./day plant in southwestern Africa for 54¢/1,000 gal.*

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## Caprolactam synthesis route aims at lowering lysine’s high price

Apparently undaunted by Du Pont’s recent decision to get out of the lysine business because it was unprofitable, Netherlands State Mines has just announced a process to synthesize lysine from caprolactam.

The Dutch chemical firm is now producing the material on a semicommercial basis, and plans to step up production by the end of the year. While synthesis details remain secret, the company claims that its process is considerably more economical than fermentation routes.

Lysine, an amino acid used mainly as a protein additive for animal and human foods, is made in the U.S. entirely from natural sources. Merck & Co. and Chas. Pfizer & Co. both use fermentation processes (*Chem. Eng.*, Feb. 1957, p. 160). General Mills extracts it from natural

products such as dried blood. As a result of this costly processing, lysine now sells at \$5/lb.

Main attraction of caprolactam synthesis is that the raw material costs only 50¢/lb. This leaves considerable margin for adding processing costs, while allowing for a lower selling price.

Du Pont had been producing lysine via furfural synthesis, but it closed down its Niagara Falls unit when it decided to quit the business.

A combination of high price and a ruling by the Food & Drug Administration that lysine could not be used in white bread (it can be used in “health” breads) have kept sales considerably below the heady predictions of two years ago. In 1959, when the market was 200,000 lb./yr., some were predicting sales of 5 million lb. by 1962. Indications now are that 1961 consumption will be well under 1 million lb.

---

## Stainless steel insulation jacket remains intact in chemical fires

Drawing upon its high mechanical strength, stainless steel is now vying with aluminum for use in insulation jacketing. Union Carbide Metals Co. recently teamed with Union Carbide Chemicals Co. to demonstrate stainless’ versatility on 20,000 sq. ft. of pipeline at Carbide Chemicals’ Institute and South Charleston, W. Va., plants.

The stainless jacket’s main selling point is safety. It will stand up under the combined stress of chemical fires and the pounding of hose streams. (Aluminum will melt in most fires.) Stainless has a higher emissivity than aluminum, which means lower surface temperatures that are less likely to cause burns.

Other advantages claimed for stainless are higher mechanical strength and greater corrosion resistance than aluminum. Stainless resists physical abuse (such as workers standing on the pipe) and is strong enough to be rested directly on a pipe rack.

Johns-Manville is now producing a line of calcium silicate insulation with a factory-applied 0.01-in. stainless jacket, under the trade name Metal-On. Cost is said to be about 8% more than conventional mastic-covered insulation and 25% more than aluminum-jacketed insulation.

Stainless sheet 36 in. wide (standard length for insulation sections) had to be rolled specially for this application since 18 in. is the usual width for 0.01-in. sheet.

# HF

aqueous and anhydrous

BUFFALO, N. Y.

CHICAGO, ILL.

EL SEGUNDO,  
CALIF.

CLEVELAND, O.

MARCUS HOOK,  
PA.

NITRO, W. VA.

PITTSBURGH, PA.

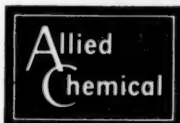
BATON ROUGE,  
LA.

## General Chemical's supply network is built around your needs for HF

General Chemical's multiple production facilities for anhydrous and aqueous Hydrofluoric Acid make us the *only* supplier to offer shipment from more than one plant! Our plants are located at Baton Rouge, La.; Marcus Hook, Pa.; and Nitro, W. Va. Deliveries of aqueous acid are also made from five strategically-located bulk storage plants in Buffalo, Chicago, Cleveland, El Segundo (California), and Pittsburgh.

This smoothly-coordinated production and delivery system is backed by a long lifeline of raw material sources: fluorspar reserves, mines, mills, and large sulfuric acid capacity.

Call or write your nearest General Chemical office for information, prices, delivery. Make General Chemical your HQ for HF!



**GENERAL CHEMICAL DIVISION**  
40 Rector Street, New York 6, N.Y.



## Plastic bio-packing handles tough waste problem, boasts cost savings

A new plastic medium for biological purification of industrial and municipal wastes has just been described by The Mead Corp., Dayton, Ohio. The corrugated grid structure is claimed to offer advantages of light weight, high surface area, and ability to handle high flow rates.

First commercial installation, treating 16 million gal./day of kraft mill waste, recently started operation at Mead's partly owned Rome Kraft Co., in Rome, Ga. Mead estimates that compared with a conventional crushed-rock trickling filter, the new unit saved a large land area and \$500,000-750,000 on installation costs.

Filter at Rome is 80 ft. in dia. and 30 ft. high. With corrugations running vertically, filter consists of ten layers of packing, each section at right angles to the ones above and below it.

Packing offers 40-50 sq. ft. of surface area per cu. ft. of material, compared with 20-25 sq. ft./cu. ft. for rock. It handles 250 million gal./day per acre of surface area, about ten times greater than rock packing.

Existing commercial plastic packings would not serve Mead's purpose because they lack the required combination of structural strength and efficiency. Further, Mead uses polyvinyl chloride at Rome because, unlike plastics used in older packings, PVC resists the heat and turpentine in the mill effluent. (Commercial packings are now made from saran, polystyrene, polyethylene and polypropylene.)

The Rome filtering plant handles waste at 120 F., compared with the usual 80 F. The PVC not only eliminates the need to precool the waste but also promotes the growth of thermophilic bacteria on the packing. These bacteria have proved more efficient than mesophilic bacteria that grow in conventional plants.

## Seeking process benefits, more firms turn to mobile data logging

To stimulate the use of mobile data logging equipment, Dresser Electronics, Houston, has just announced that it is making such units available on a lease basis.

This move, which may be duplicated by other manufacturers, will be of special interest to smaller chemical firms. They now can obtain

process information, which can only be gathered with logging equipment, without investing the \$50-125,000 that a completely equipped van costs. Most minimum-lease periods will be less than one year.

Shell Development, long an advocate of data logging, is currently updating its equipment with a new system designed by its Deer Park, Tex., engineering group. System includes a Packard-Bell PB 250 digital computer, having ability to accept sixty inputs from any process variable—electronic or pneumatic. (Its old van didn't have a computer.) New unit will be operating by early summer.

Phillips Petroleum, another old hand at data logging (*Chem. Eng.*, Dec. 12, 1960, p. 153) now has its van at its Borger, Tex., refinery. The unit, built around North American Aviation's Recomp II computer, proved its worth at Phillips' Sweeny, Tex., ethylene plant where it led to improvements that increased capacity by 10%. And an additional 6% could have been squeezed out by on-line computer control, but Phillips felt the return was not worth the additional investment.

The company has also used its analyzers (without the logger-computer) to optimize recovery of liquids from natural gas processing plants.

## Research and Development Briefs

**Separation of hafnium and zirconium**, ordinarily very difficult to distinguish chemically, can be effected by single-stage anion exchange, reports the National Bureau of Standards. The sample is dissolved in a sulfuric-hydrofluoric acid solution, then is loaded on a strong quaternary-amine resin. Hafnium and then zirconium are eluted selectively by a 3.5% sulfuric acid solution with a cross-contamination of only a few parts per million.

**"Molecularized" components** can make possible a computer one-tenth the size and weight of present transistorized models, declares Westinghouse Electric. Secret is a solid semiconductor crystal that performs the functions of tubes, transistors and resistors, through internal rearrangement to form a functional electronic block. In its Mol-E-Com computer now under development for space applications, these blocks will perform intricate operations such as switching and amplification.

For More Industry & Economic News . . . p. 60

# ENGINEERING

NEWS YOU CAN USE ABOUT ENGINE AND COMPRESSOR PERFORMANCE

## Why these packing rings are hermetically sealed



**No doubt about it,** these Cook packing rings have received very special treatment.

Immediately after manufacture, they were carefully inspected, oiled, then hermetically sealed in a plastic bag to protect against dirt, moisture, and damaging corrosive atmospheres. You can be sure that the quality and precision of these Cook rings will not deteriorate before they're put into service.

This "red carpet" handling of a very important item is but another example of Cook's attention to detail—resulting in continued superiority of the finished product.

Cook packing rings are precision made to always give you a perfect seal—no matter how difficult the special sealing requirements of your application. Ask a C. Lee Cook representative for complete information. Or, write C. Lee Cook Division, Dover Corporation, 958 South 8th Street, Louisville, Kentucky.



**C. LEE  
COOK**

DIVISION OF **DOVER** CORPORATION

*Rings and Packings Since 1888*

Major portions of this SBR rubber processing line . . .



## ENGINEERS GRAFT STEREO PLANT ONTO SBR LINE TO SPEED PRODUCTION OF NEW RUBBER

*Goodrich-Gulf's first cis-polybutadiene plant is rising from an existing SBR facility at Institute, W. Va. Conversion requires few major changes.*

Goodrich-Gulf Chemicals is minimizing the time and capital investment needed to build a commercial cis-polybutadiene (Ameripol CB) plant by converting an existing styrene-butadiene rubber production line at its Institute, W. Va., manufacturing center into the new process. When completed, the facility will have a capacity of 20 million lb./yr.

The new line will utilize a technique developed by Goodrich-Gulf that employs Ziegler-type cobalt-based catalysts. By this means, the company expects to manufacture a polymer with cis content of  $98 \pm 1\%$ . Equally important, vinyl content will be reduced to less than 1%.

► **Ready-Made Market**—According to Paul W. Cornell, vice president of research and development, the decision to take the conversion ap-

proach to plant-scale manufacture of polybutadiene was based on the following economic and technical factors:

- The synthetic rubber industry is faced with an excess of SBR capacity.

- Extensive truck-tire tests have shown that treads of polybutadiene will wear 60-70% longer than those of natural rubber. This should assure an immediate market for the improved rubber.

- A strong possibility exists that when volume production is achieved the new polymer will become directly competitive with SBR.

► **Few Problems Posed**—Production of polybutadiene involves certain steps common to the SBR process (see drawing above). For example, pigment preparation and polymerization are still required, and in the same sequence. Such elements as short stopping, stripping, blending and antioxidant addition are also required. Drying, packaging, warehousing and shipping are common to the two products.

Pigment preparation for polybutadiene, however, is considerably more involved than for SBR. This is due to the fact that the oriented

rubber must be produced in an entirely dry system, whereas SBR is prepared in a water emulsion.

To overcome these differences, three basic steps will be added to the SBR line: (1) complete drying of all materials used in the polymerization, (2) recovery and purification of the hydrocarbon solvent employed, (3) removal of the spent catalyst fragments.

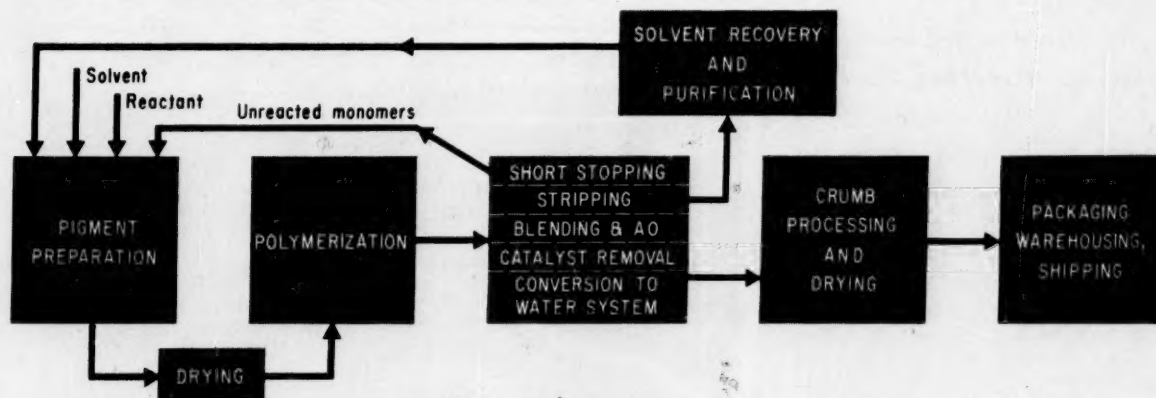
Company engineers found that removal of the catalyst, while requiring skill, was a relatively simple and inexpensive operation. Major problems were those of preparing completely dry raw materials, and recovery and purification of the solvent.

To make maximum use of the existing drying equipment, the cement system (obtained from the polymerization step) must be converted to a water system, so that the crumb can be processed similar to SBR. It is, of course, possible to dry polybutadiene directly from the hydrocarbon solvent, but this would require different equipment and pose a number of additional problems, including plant and personnel hazards.

► **The New Route**—First step in the revised layout is combining dry



... remain after conversion to polybutadiene process



solvent and monomer in the proper ratios to provide the feed to polymerization. To be sure that the streams contain no moisture, a drying step will be installed between the pigment preparation tank and the polymerization step (see above).

Polymerization will be carried out in the present SBR units. The short stopping, stripping and blending steps will be combined with antioxidant addition, catalyst removal and conversion of the polymer from a solvent to a water system. It is here that the reaction is stopped and the unreacted monomers returned to the pigment preparation stage.

Also at this point, the solvent is recovered. Since impurities may leave via the solvent, a purification step will be provided here.

► **Cobalt Catalyst Best**—Three catalyst systems have been proposed for the commercial polymerization of butadiene to produce an oriented product. Two of these employ catalysts of the Ziegler type, one using cobalt and the other titanium as the heavy metal.

Goodrich-Gulf scientists found the cobalt catalyst particularly suitable for Ameripol CB. With it, the *cis* content of the polymer can be increased from the 85-94% obtainable with titanium, to  $98 \pm 1\%$ . The vinyl content, which has a detrimental effect on the rubber's properties, can be reduced from 2-3%

obtained with titanium, to less than 1% with cobalt.

A third catalyst system that has been used in the polymerization of isoprene involves use of lithium compounds. This metal is somewhat less specific than the other two, resulting in a *cis* content of about 35% and a vinyl content of 13%.

The properties considered most desirable for the vast majority of rubber uses are the highest possible *cis* content and a minimum of vinyl structure. It, therefore, became important to capitalize on the ability of the cobalt catalyst to provide these features. Design of the plant was fixed with this in mind.

## Five Societies Tackle Control Topics Together

This week, five technical societies (AIChE, ASME, AIEE, ISA, IRE) meet in Boulder, Colo., at the second Joint Automatic Control Conference.

After a fitful start last year at M.I.T.—there were only a few papers from chemical engineers—the meeting this year promises more for process-oriented personnel who are interested in control. And among the more promising developments is an increased awareness of economics.

Harold Chestnut of General Electric Co., for example, has pre-

Ameripol CB is somewhat easier to dry than might be expected and can be readily handled in the usual flight dryer or extrusion.

The cold-flow properties of the polymer are favorable, so no unusual problems should be encountered with the customary packaging, warehousing and shipping procedures.

Goodrich-Gulf's licenses for the production of Ameripol CB are available on the chemistry alone, the chemistry together with the process engineering, for either a new plant or a conversion such as the one now being carried out at Institute.—AVG

pared a paper on cost models for systems engineering. A well-known control engineer, Chestnut has mustered experience in formulating on-line control operating costs to develop literal mathematical cost expressions in initial design stages.

Every day of the three-day meeting (starting June 28) will be crammed with interdisciplinary information of interest to chemical engineers. Besides the opening-day session on economics, there will be meetings on optimization, process dynamics, adaptive control, and nonlinear control systems. Representatives from process firms noted for control applications will contribute.



## OVERSEAS PROJECTS SPUR CARBON BLACK GROWTH

*Between now and the end of 1962, U. S. carbon black interests will build more foreign than domestic capacity, to keep pace with the growth of overseas markets.*

By the end of 1962, capacity for carbon black in the free world will probably total some 4 billion lb./year. This will be a 700-million-lb. gain over the present estimated 3.3-billion-lb. capacity.

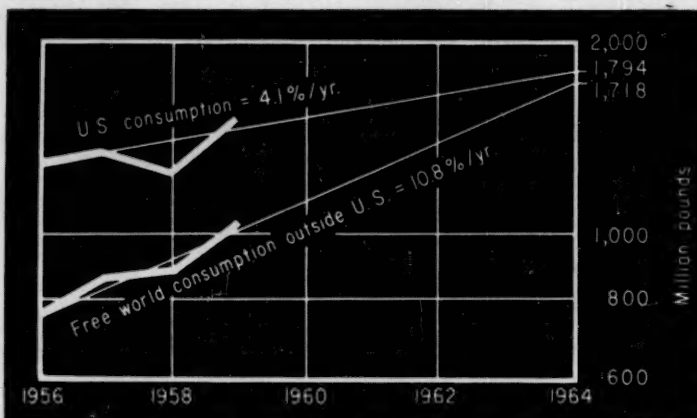
Screened behind this major expansion is a further trend away from the near monopoly once enjoyed by the U.S. Of the new capacity, only 254 million lb. will be in this country. Nevertheless, the U.S. will remain by far the largest maker of carbon black, with 2.5 billion lb. output by 1962.

The major upsurge in overseas capacity is stimulated by a market for black that is growing at 10.8%/year, more than double the 4.1% U.S. rate. Reason: the rubber industry—which takes over 95% of carbon black output—is expanding abroad at a rate that is more than twice as great as that of this country.

► **Foreign Growth**—As recently as 1955, Free World consumption of synthetic rubber outside of the U.S. was as little as 12% of total rubber hydrocarbon consumption. This percentage was more than doubled by 1959 and the actual tonnage tripled from 167,000 to 502,000 long tons in the same period. As foreign nations become more and more industrialized, demand for autos, trucks, buses and other tire products, plus heavy demand for non-tire products will continue to boost demand for rubber and carbon black.

► **Exports to Dwindle**—Accordingly, exports of carbon black during the past few years have accounted for about 25% of all shipments from U.S. producers. This comes to roughly 500 million

### Out of pressing overseas carbon black demand . . .



### . . . fast-growing foreign capacity

(Million Pounds)	Year 1960 Total Capacity	Oil Furnace Proposals	By Year 1962 Total Capacity
United States . . . . .	2,415	254	2,669
Less: Channel black shutdowns (estimated)			182
<b>Total United States</b>			<b>2,487</b>
Canada . . . . .	85	40	125
Mexico . . . . .	0	20	20
<b>Free Continental Europe</b>			
West Germany . . . . .	142	0	142
France . . . . .	113	105	218
Italy . . . . .	31	85	116
Netherlands . . . . .	80	0	80
Belgium . . . . .	10	0	10
<b>Total</b>	<b>376</b>	<b>190</b>	<b>566</b>
United Kingdom . . . . .	337	0	337
<b>South America</b>			
Brazil . . . . .	40	65	105
Argentina . . . . .	0	28	28
Venezuela . . . . .	0	20	20
<b>Total</b>	<b>40</b>	<b>113</b>	<b>153</b>
<b>Far and Middle East</b>			
Australia . . . . .	28	30	58
India . . . . .	0	30	30
Japan . . . . .	54	100	154
West Pakistan . . . . .	0	22	22
<b>Total</b>	<b>82</b>	<b>196</b>	<b>278</b>
Union of South Africa . . . . .	0	22	22
<b>Total Excluding U. S.</b>	<b>920</b>	<b>581</b>	<b>1,501</b>
<b>Total Free World</b>	<b>3,335</b>	<b>835</b>	<b>3,988</b>

Note: Does not include lampblack, acetylene black or noncompetitive blacks. Sources: U.S. Bureau of Mines and Cabot Corp. estimates.



## HE'S DRINKING A CORROSIVE LIQUID

It's only a drink of water, but it can be highly corrosive—the water source determines to a great extent just how corrosive it is.

Ground water from Utah, for example, is chemically different than ground water from New York . . . different enough to require a pump of different material to handle it most economically. In fact, there's nothing simple about handling water. Salt water, brackish water, hot water—each calls for a different pump material for best performance and longest pump life.

Take another example—distilled water. It's harmless to drink but it can eat the heart out of a pump. Distilled, deionized or

demineralized water tends to corrode ordinary metals, and in doing so, the water becomes contaminated. In fact, the purer the water, the more corrosive it is. Worthington uses "Worhite"—a "super stainless" steel—to resist this corrosion and

prevent contamination. Worhite will last indefinitely on distilled water service.

We at Worthington have accumulated a virtual encyclopedia of facts about water handling. Long years of experience have taught us how to select the proper pump for all types of water (or any other liquid) handling applications.

The next time you have a water handling problem, call Worthington—the manufacturer whose name is synonymous with pumps. You'll find your nearest Worthington district office or distributor in the yellow pages. Worthington Corporation, Harrison, New Jersey.



**WORTHINGTON**

**U. S. carbon black production**

(Thousand pounds)

	Gas Black	Oil Black	% of Total	
1957	872,363	926,062	51.5	
1958	739,636	904,969	55.0	
1959	858,025	1,109,502	56.4	
1960	833,247	1,219,000	59.4	
1961	730,000	1,300,000	64.0	
1963	600,000	1,450,000	70.7	
	Channel Process	Furnace Process	% of Total	Total
1957	357,557	1,440,868	80	1,798,425
1958	324,743	1,319,862	80	1,644,605
1959	321,030	1,646,497	84	1,967,527
1960	292,355	1,759,892	86	2,052,247
1961	229,000	1,801,000	89	2,030,000
1963	150,000	1,900,000	93	2,050,000

Sources: U. S. Bureau of Mines and Cabot Corp. estimates.

lb./yr. Synthetic rubber capacity in the Free World, outside, of the U. S., is due to grow from 678,000 long tons at the beginning of 1961 to 1.4 million long tons by 1965.\* (U.S. capacity will go from 1.8 million long tons to 2 million.) But present and projected carbon black expansion overseas will be more than enough to cover local demand, with the result that U.S. exports will decline. The industry expects them to drop from 543 million lb. in 1960 to 350 million in 1963.

Any decrease in exports, however, will not be a total loss to U. S. carbon black firms. Almost all of the new overseas plants will be financed wholly or partly by American capital. Companies exporting manufacturing and sales techniques include such industry leaders as Cabot, United Carbon, Continental Carbon, Columbian Carbon and Phillips Petroleum.

Another factor, beside the very rapid growth of rubber use outside the U. S., affects producers' plans to build plants in overseas market areas. Increasing amounts of carbon black are being made from oil

rather than from natural gas. This makes it possible to obtain and transport raw material to plants in most parts of the world.

► **Oil vs. Gas**—At present, 59.4% of all blacks stem from oil, 40.6% from gas. As recently as 1953, these figures were reversed. This shifting should continue; all of the new plants under construction or in the planning stage are being based on oil. By 1963, the ratio is expected to be 70.7 to 29.3% in favor of oil.

Reason for the shift is the rising price of natural gas in relation to oil. Price of natural gas to carbon black producers climbed from 7.92¢/M cu. ft. in 1955 to 10.05¢ in 1960. Liquid hydrocarbon's price went from 6.19¢ to 7.05¢/gal.

The economics of oil vs. gas has also contributed to the decline of the channel process (the incomplete combustion of natural gas in small flames, which impinge on channel irons). Before World War II, about 80% of all carbon blacks were made by the channel process. Now, the furnace process, continuous partial combustion of either gas or oil, has over 80% of the business.

► **Furnace vs. Channel Process**—

Furnace blacks first became popular because they worked better than channel blacks in synthetic rubbers. Since then, their popularity has been aided by the price difference between gas and oil. Also, the furnace process seems cheaper to operate, aside from raw materials. Eventually, it may take over completely, except for some special uses that require channel blacks.

Even channel blacks' claims to special properties are being weakened. Both Columbia Carbon and Cabot Corp. have developed and commercialized new all-oil processes for making carbons formerly producible only via the channel process. The new products are primarily the result of learning to control carbon black structure. Channel blacks have conventionally taken the form of discrete particles whereas oil-based blacks are agglomerates. The particulate structure, now available from oil base, has special advantages for such uses as off-the-road truck tires, where exceptional resistance to chipping, cutting and skidding is desirable.—FA

**Mineral Data Sought From Western Chemical Firms**

Chemical producers in California and Nevada are being asked by the Bureau of Mines to participate in a survey of nonfuel consumption of minerals and metals.

The canvass, first of its kind conducted by the bureau, is expected to show types, amounts and sources of mineral raw materials that are being used by the chemical industry. The bureau hopes to obtain data from each chemical plant in the two states. Information is to be used primarily to guide economic and defense planning, but should also be valuable to industry, the bureau notes.

Information concerning the canvass can be obtained from W. W. Key, Bureau of Mines, 555 Battery St., San Francisco 11, Calif.

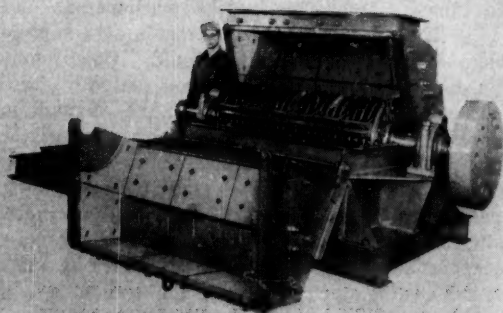
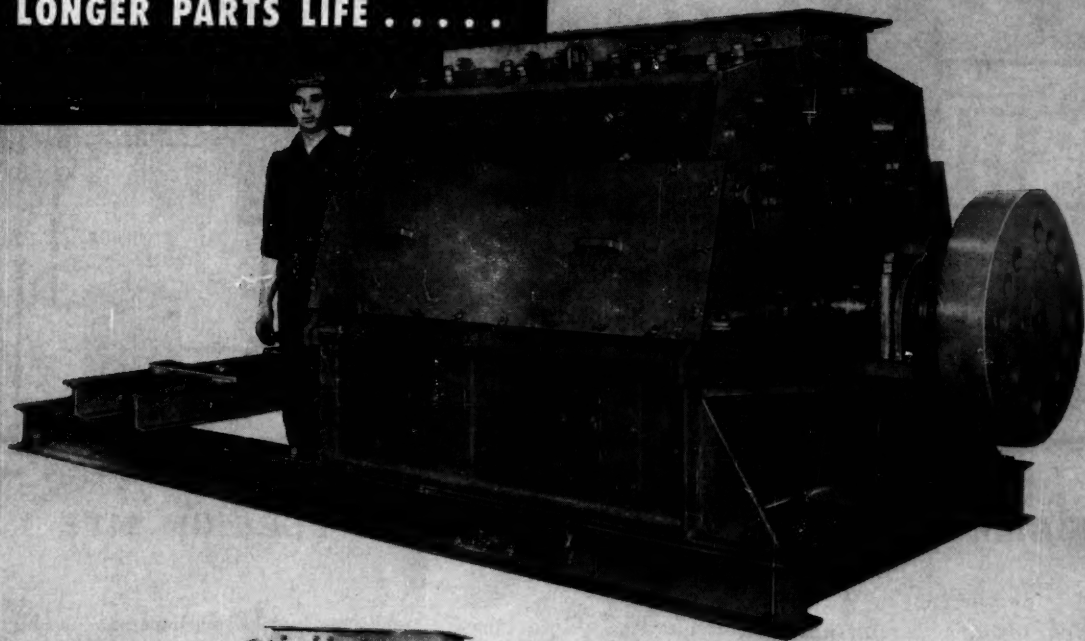
\*Texas-U. S. Chemical Co. estimates.

# NEW

DUAL "2-POINT"  
ADJUSTMENT INSURES  
MORE UNIFORM GRINDING,  
LONGER PARTS LIFE . . . . .

## WILLIAMS

## Reversible HAMMER MILLS



Williams Reversible Hammer Mill with cover open.  
Note these features:

- Super-strong reinforced steel plate frame
- Renewable wear-resistant manganese steel liners
- Heavy duty oversize forged steel rotor shaft
- Anti-friction self-aligning roller bearings in dust-tight housings
- Complete accessibility to interior for quick parts changing

**It's another Williams "first"**—features not available in other hammer mills—that now makes it possible to maintain the original close clearances of *both* grinding plates *AND* cage sections against the rotating hammers. This easy-to-make "2-point" adjustment, in the most critical grinding area inside the hammer mill, gives absolute assurance of consistently uniform product quality.

In addition to the advantages of the Dual "2-Point" Adjustment, a Williams Reversible Hammer Mill substantially lowers upkeep expense by

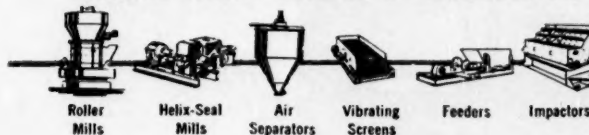
**WILLIAMS PATENT CRUSHER & PULVERIZER CO.**

cutting hammer cost. Hammers can be operated in one direction today and another tomorrow simply by installing a simple reversing switch on the driving motor. Manual reversing of hammers no longer necessary. Grate bars also last longer. The double set of reversible manganese breaker plates, which last twice as long as other types, give four times the service! Maintenance and downtime are cut 50% or more.

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Roller Mills

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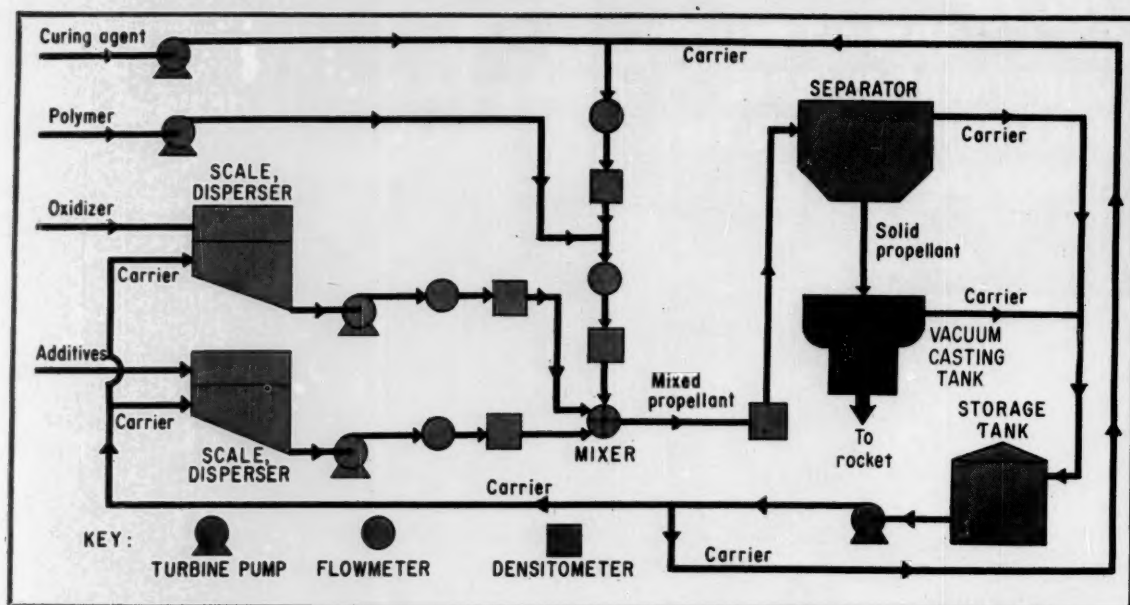
# WILLIAMS

CRUSHERS GRINDERS SHREDDERS

Oldest and Largest Manufacturers of Hammer Mills in the World







## MOBILE BLENDER MIXES SOLID ROCKET FUEL ON SITE

*Rocketdyne's continuous-processing unit on trailer demonstrates feasibility of field-loading large solid-propellant rocket motors.*

A mobile, continuous mixer that blends rocket solid-propellant formulas to pushbutton specifications is being piloted at McGregor, Tex. (with 11 successful runs just completed).

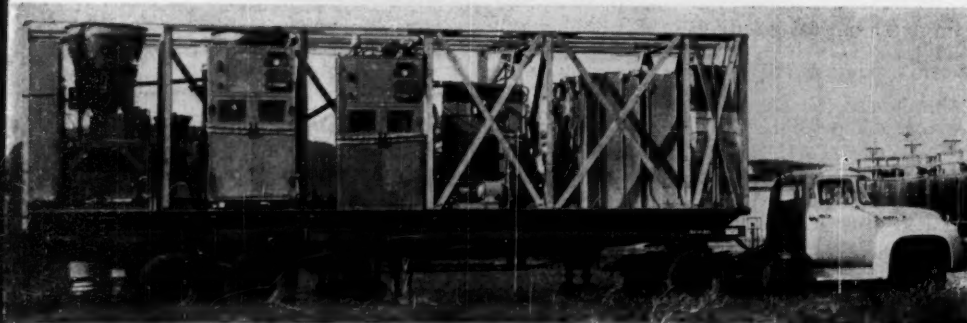
Rocketdyne Div. of North Amer-

ican Aviation, Inc., calls its technique Quickmix, bills it as "the answer to the problem of field-loading very large [up to 500 tons] solid-propellant rocket motors." Whether or not Quickmix is the answer, the impracticability of transporting fueled-up rockets from factory to launch pad has called for a method of on-site fuel mixing, thus permitting rocket bodies to be shipped in segments for loading and assembly at the blastoff site.

► **Outline of Technique**—Basically, here's how Quickmix works: The propellant's solid components are

separately predispersed in high-velocity streams of a volatile, low-density liquid. Components and carrier are mutually insoluble; by spurring the various makeup streams through a jet nozzle, components are integrally mixed almost instantaneously. Safety is built in, since only a minute quantity of the highly explosive propellant is in the mixer at one time—and then for less than a second. Automation is inherent.

In operation since 1959, Rocketdyne's 500-lb./hr. pilot plant has mixed all given propellants faster,



It's a long haul from California to Texas—but pilot plant on wheels proves feasibility of commercial caravan for field-loading solid-propellant rockets.

# IDEAS IN HYDRIDES!



## MHI's Tech Service/Custom Reaction Team Can Link Your Ideas to a Process Reality

It's happening every day! Processors — like yourself — who suspect that hydrides might solve a problem or boost process efficiency call on MHI. With unparalleled experience in the field of hydride chemistry, MHI technical service engineers can give you fast and accurate answers based on the most up-to-date information. If this initial evaluation indicates your idea can be linked to a reality — MHI's Custom Reaction service can prove the point through pilot plant experimentation.

Just recently, for example, MHI has turned inspiration into profit for a group of thoughtful steroid chemists. Confronted with the idea that perhaps the exceptional selectivity of one of the hydrides could solve the problem of specific functional group reductions

in coddled complex molecules, MHI proved that lithium aluminum hydride was indeed the answer.

Perhaps you've got a hydride idea. Why not discuss it with an MHI technical service engineer? If it has merit, you can call on MHI's custom reaction team to develop it to a profitable process reality for you at surprisingly low cost!

### ..... Contact MHI technical service! .....

.....  
Information is readily available concerning: Calcium  
Hydride • Lithium Aluminum Hydride • Potassium  
Borohydride • Sodium Borohydride • Sodium Hydride  
Oil Dispersion • Titanium Hydride • Zirconium Hydride  
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***Metal Hydrides Incorporated***

308 CONGRESS STREET, BEVERLY, MASSACHUSETTS

PIONEERS IN HYDRIDE CHEMISTRY



Tiny jet mixer, key to Quickmix, blends 500 lb./hr. of solid fuel.

cheaper, safer and more uniformly than any conventional batch-mix technique.

**Faster**—Mixing by nozzle injection is virtually instantaneous. Batch system needs stirring.

**Cheaper** — Conventional batch-mix method would require six 200-gal. mixers (or their equivalent) for a 5,000-lb./hr. capacity; such a system costs about three times as much as a Quickmix plant of same capacity.

**Safer**—Propellant is retained in the mixer for a fraction of a second; mixer itself is friction-free, has no moving parts, is in fact the smallest piece of major equipment in the system (a 2,000-lb./hr. mixer could be held in one hand).

**More Uniform**—Better distribution of ingredients, greater reproducibility and denser product were all features displayed by Quickmix in the tests.

**Mobility** — But the heart of Quickmix is its mobility. The pilot plant was built on skids at Santa Susana, Calif., operated there for several months, and then placed on an 8 x 35-ft. flatbed trailer and wheeled to the McGregor, Tex., site.

Rocketdyne designers visualize a commercial Quickmix system on six trailers: one to house the control panel and central field office; a second to house electrical, air and steam heating systems; a third to store, activate and fluidize the dry oxidizer; a fourth to carry the mix-

ing head; a fifth for curing the raw, just-mixed fuel; and the last to support casting hardware (i.e., for casting the solid fuel into the rocket engine itself).

**►Details of the Process**—Rocketdyne's C. F. Dougherty and J. M. Reiley describe the "innards" of Quickmix in a paper titled "Quickmix—An Answer to On-Site Loading," delivered before the American Rocket Society's Missiles and Space Vehicles conference in Los Angeles.

Briefly, the solid raw materials (oxidizer, curing agent, polymer and miscellaneous additives) are individually, continuously weighed into the liquid carrier (see flow diagram). Turbine pumps insure adequate circulation of the separate slurries to maintain uniform suspensions; the required mass flow rates are established and monitored by gamma-ray densitometers and turbine flowmeters.

Spurred into a single stream by the fist-sized mixer, propellant

passes through another densitometer (monitoring for total solids) and on to the separator. Here, propellant settles rapidly. Carrier is decanted, and finished propellant is cast into the rocket-engine casing for in-place curing.

McGregor unit has an open-loop operator tracking mode; full-scale design, however, specifies closed-loop computer control.

**►Safety Is Stressed** — Some of Quickmix' standout safety features have already been noted. Others:

- Lack of pumps (and hence of friction) downstream from the mixing nozzle.

- Fresh carrier pump throat and seal flush system, to prevent explosive components being worked into pump parts.

- Nitrogen gas purge on both oxidizer and additives scale hoppers, thus precluding vapor backup and condensation on solids.

- Selected temperature- and pressure-point monitors.

## MARKETERS FORESEE PROFIT BATTLE

Reduced profits, overcapacity and foreign competition in the world market drew pungent comment from speakers at the 21st annual meeting of the Chemical Market Research Assn. in New York, May 18.

Howard C. E. Johnson, editor of *Chemical Week*, seemed to sum up a general feeling with, "As long as raw materials are cheap and plentiful, and production capacity is more than ample, the pressure on prices is inexorable."

In specific comments to the plastics industry, Johnson went on to point out that the favorable export-import ratio in plastic material would soon be a thing of the past. He proposed that, "The best hope of sharing in the profits to be gained by satisfying the world's increasing hunger for plastic products is to build plants to supply local markets—either through international divisions, foreign subsidiaries or joint ventures."

As for the profit squeeze, men in the synthetic fiber and synthetic

rubber fields seemed the most worried. In synthetic fibers, for example, Du Pont's Frank Salisbury was of the opinion that "volume and variety of fibers will increase, while shrinking profit margins should be expected."

Key marketing facts about certain segments of the CPI were brought out during the meeting:

- Chlor-alkali—The industry growth rate for the next five years will be 4.5% per year, down from the 10% per year during the last decade.

- Synthetic fibers—Total consumption of all fibers in the U.S. has not changed for several years, while man-made fibers have steadily increased their share of this market.

- Fertilizers—The price situation in 1961 will remain firm because of improved farm income and the possibility of a tight supply situation. The growth of the home fertilizer market may have an important sales effect on the segment's future.



## Versatile Ashland Oil Process Relieves World-Wide Naphthalene Shortage

MARCH, 1961 . . . OUT OF ASHLAND, KENTUCKY, tank car after tank car, each containing 10,000 gallons of *highest purity* naphthalene, headed for such companies as Reichhold, American Cyanamid, Sherwin-Williams, Standard Naphthalene Products, and Witco. These cars contained the first shipments of naphthalene to come out of Ashland Oil's *patented* Hydrodealkylation Unit . . . *the world's first Hydeal Unit capable of producing naphthalene from petroleum in commercial quantities!* Capacity: from 75 to 100 million pounds of high purity naphthalene per year, enough to eliminate domestic shortages . . . enough to alleviate world-wide shortages!

BUT MOST IMPORTANT TO YOU and

your operations are the product possibilities offered by Ashland Oil's revolutionary Hydeal Unit through its manufacture of petrochemical "building blocks" used in the Fiber, Plastics, Rubber and Coating Industries. Ashland Oil places its complete facilities at your disposal . . . will work with you on all products and potential uses of these petrochemical "building blocks," including all necessary studies and economic evaluations pertaining to your requirements. Look to the future, and look to Ashland Oil as a prime source of supply for high purity naphthalene, benzene, toluene, xylene, and heavy aromatic concentrates. For complete information, call or write: National Account Department, Ashland, Kentucky . . . Phone: 324-1111.



**ASHLAND OIL & REFINING COMPANY**  
**ASHLAND, KENTUCKY**



## AUTOMATIC MOISTURE ANALYZERS MONITOR GAS AND LIQUID STREAMS

*Three years of experience show that portable and continuous instruments deliver accurate moisture readings with minimum maintenance.*

Automatic moisture analyzers have proved their ability to detect moisture levels in the parts per million range, and can dependably monitor a variety of streams directly on the process line.

Reporting to the American Petroleum Institute, L. M. Johnson and R. C. Halter, Humble Oil and Refining Co., pointed out the advancement made in the past three years in the measurement of trace water in refinery and petrochemical process streams.

Electrolytic moisture analyzers are commercially available from Beckman Instruments, Inc., Consolidated Electrodynamics Corp., and Manufacturers Engineering and Equipment Corp.; they will measure water in gas streams in concentration ranges from 0-10 to 0-1,000 ppm. and higher.

► **Analyze Liquids, Too**—In addition, the latter two companies sell instruments for determination of moisture in liquid streams. These devices measure water content indirectly by first stripping the moisture from the liquid with a dry gas, then analyzing the gas for moisture.

Successful applications of automatic analyzers include a variety of streams, such as air, nitrogen, helium, hydrogen, light hydrocarbons, refrigerants, kerosene, benzene, xylenes and lubricating oil.

Most of the light hydrocarbon gases have been monitored to determine moisture breakthrough on gas dryers. Ethylene streams, and mixed streams containing methane, ethane, ethylene, propane, propylene, butanes, butylene, carbon monoxide, nitrogen and hydrogen, have been analyzed for exten-

sive periods, with negligible maintenance required for the instruments.

► **High Values Reported**—One difficulty with this type of analysis is that moisture in streams containing high concentrations of hydrogen and oxygen is always reported to be much greater than the actual content. Apparently some of the electrolysis products combine with the incoming hydrogen or oxygen in the cell to form water, which is again electrolyzed and reported.

Such an error may reach several hundred percent, so for streams containing high concentrations of the two elements, the analyzer can be used only as a trend indicator, reporting gross changes in concentration.

► **How They Work**—Operation of these analyzers depends on the simultaneous quantitative absorption and electrolysis of water from a flowing gas stream. The stream passes into a cell containing two platinum electrodes surrounded by a film of phosphorus pentoxide. Water, absorbed by the pentoxide, is continuously electrolyzed by a d.c. potential across the electrodes.

The current produced is directly related (Faraday's law) to the amount of water electrolyzed. If the flow rate of gas through the cell is accurately controlled, the theoretical current for 1 ppm. of water in the given volume, per unit time, can be calculated, and the instrument calibrated to read ppm., directly as a function of the unit current established.

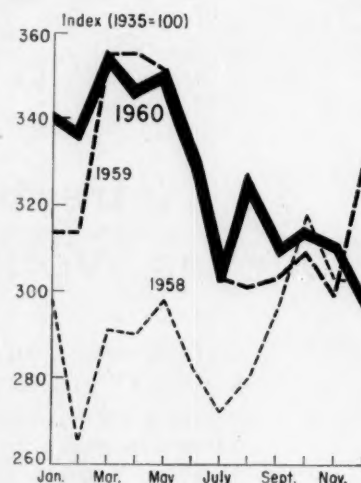
► **Considerations for Accuracy**—Accuracy of the determinations is critically affected by a variety of conditions that must be considered when an installation is made.

Surface area of the sampling system must be held to a minimum lest water adsorbed and desorbed by the walls change the concentration in the sample.

Particles larger than 5 microns must be filtered from the sample;

sintered stainless steel elements seem to do the job best. Finally, atmospheric moisture must be excluded from the system. Rubber and many plastics cannot be used because they are so permeable that in spite of high opposing pressures, atmospheric moisture can diffuse into the sample, and cause an error of several hundred per cent in the determination.

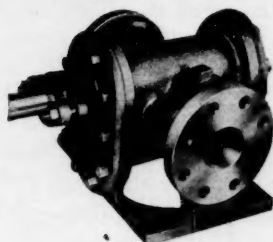
And most important to accuracy, sample flow must be rigidly controlled, since the calibration and all subsequent results are based on a given volume of sample gas passing through the instrument in a specific time period.



### Chemical Consumption Index

	Dec. (Final)	Jan. (Est.)
Coal products .....	6.3	6.2
Explosives .....	11.4	10.0
Fertilizer .....	73.2	81.6
Glass .....	24.8	26.7
Iron & steel .....	10.7	11.8
Leather .....	3.8	4.1
Paint & varnish .....	26.6	30.2
Petroleum refining .....	32.3	33.6
Plastics .....	32.4	29.2
Pulp & paper .....	37.3	41.4
Rayon .....	22.6	23.1
Rubber .....	6.2	6.7
Textiles .....	8.4	9.3
<b>Total .....</b>	<b>296.0</b>	<b>313.9</b>

## SK Gear Pumps HANDLE MANY MATERIALS



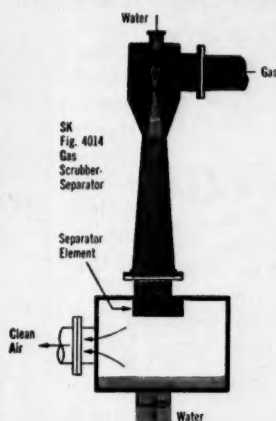
Engineers in all types of plants are using SK Gear Pumps to handle materials ranging from kerosene to glue. Time after time these pumps have replaced other types in critical applications. In case after case they have solved costly maintenance or poor performance problems. And, what they have done for others they can also do for you. Why not tell us about your application. We'll be glad to help.



For details—ask for Bulletin G-1

## SK Introduces New GAS SCRUBBER-SEPARATOR

New "packaged" unit offers never-before-obtainable efficiency. Combines SK ejector-venturi scrubber with new separator which reduces liquid carryover to 0.00002 gal. per 100 cfm. Unit, called "Fig. 4014" is low cost, compact. Stocked in popular sizes for immediate shipment.

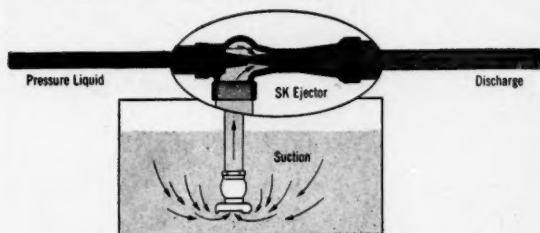


For details—ask for Bulletin Supplement 4R.

## SK Liquid Jet Ejectors PUMP AND MIX SIMULTANEOUSLY

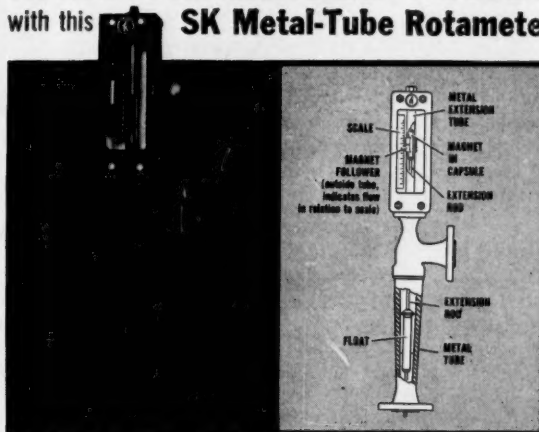
SK Liquid Jet Ejectors utilize the kinetic energy of a liquid under pressure to entrain, mix, and pump liquids or handle slurries and granular solids. Uses vary from pumping out a sump to mixing chemicals in proper proportions.

Some user benefits: (1) *economy*—a 2-inch, bronze unit costs only \$51.00; (2) *maintenance-free service*—simple construction and lack of moving parts makes supervision unnecessary; (3) *availability*—stocked in popular sizes in Pennsylvania, Texas, California; (4) *adaptability*—made and stocked in cast iron, bronze, stainless steel, asbestos-filled resin, PYREX brand tubing, and PVC.



For details—ask for Bulletin 2M

## Measure Rate-of-Flow of HARD-TO-HANDLE FLUIDS with this SK Metal-Tube Rotameter



SK Metal-Tube (Armored) Rotameters are designed for measuring the rate-of-flow of hazardous fluids, high pressure fluids, and steam. Their accuracy, sound design, and sturdy construction make these instruments easy to apply and easy to use in direct and remote indicating, recording and controlling installations.



For details—ask for Bulletin 19A.

JET APPARATUS: Ask for Condensed Bulletin J-1.

ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.

VALVES: Ask for Condensed Bulletin V-1.

HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.

GEAR PUMPS: Ask for Bulletin G-1.



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## HOW WILL PRODUCERS OF COKE-OVEN AROMATICS REACT TO COMPETITION?

*Two proposals have been advanced to counter the petroleum refiners' advantage of greater product purity.*

With the surge in new petroleum benzene and naphthalene capacity, producers of aromatics from coal tar are pondering a question that might be best summed up as: What happens now?

This is the situation they face. Petroleum refiners will have a capacity of about 756 million gal./yr. benzene by 1962, an increase of 390 million gal. over the 1960 level. Petronaphthalene capacity will jump from present level of 100 million lb./yr. to about 450 million lb. by the end of 1962. Capacity for these materials from coke oven sources will remain relatively static: about 210 million gal. for benzene, 650 million lb. for naphthalene.

In addition, the petroleum aromatics have much lower thiophene sulfur content. Petrochemical naphthalene and benzene are under 5 ppm. thiophene, while their coke-oven counterparts may have over 1,000 ppm.

Two alternatives for meeting this new challenge have been offered to coke-oven operators. Harry Pfann, of Pittsburgh Chemical Co., speaking at a recent Commercial Chemical Development Assn. meeting in New York, suggested that a dual pricing system might be worked out.

Petronaphthalene, for example, is ideally suited to fluid-bed phthalic anhydride manufacture because of its low sulfur content. Conventional fixed-bed phthalic makers, however, can operate satisfactorily on the higher-sulfur coke-oven product and would stick to their conventional sources if a price differential were established. (Right now, both types of naphthalene are selling for around 6¢/lb.) Pfann points out that there already is a precedent for this

in refined moth-ball grade naphthalene, which sells for around 12¢/lb.

The alternative to lowering the price to counter the petroleum refiner's purity advantage, suggests Martin Faye of U. S. Industrial Chemicals Co., is to upgrade coke-oven products by lowering sulfur content. In a paper given before the American Coke & Coal Chemicals Institute meeting in Rye, New York, Faye outlined three processes piloted by USI to remove sulfur via sodium treating. Naphthalene or the BTX cuts (benzene, toluene, xylene) can be produced with less than 1 ppm. thiophene.

USI has two processes for treating acid-washed light oil, one utilizing a jacketed ribbon-blender for small plants and the other a fluid-bed system for larger plants (over 10,000 gal./day).

The jacketed blender contains 2-6% sodium metal on an inert carrier (e.g., silica sand, blast furnace slag). Benzene feeds through a rotameter to a vaporizer and then to the reactor. Direct operating costs for this system, 1.55¢/gal.

Fluid-bed system for larger installations makes use of suspended 80-200 mesh solids (preferably silica sand or blast furnace slag) containing 2.5-3% sodium. Operating costs for this system, 0.86¢/gal.

Investment for the 10,000-gal./day mechanically agitated system is around \$200,000. An outlay of about \$350,000 is needed for a 30,000-gal./day fluid-bed plant.

Desulfurizing of naphthalene is simpler. Metallic sodium can be added directly to agitated batch tanks containing liquid naphthalene. Purified product is then recovered by distillation.

Investment for a 10-million-lb./yr. plant would be only about \$50,000, with direct operating costs estimated at 0.57¢/lb.

### ChE's to hear about "New Trends in Chemistry"

*Titles and authors of the papers to be presented at the conference on "New Trends in Chemistry" have just been announced by the program committee. Sponsored by Armour Research Foundation and Chemical Engineering, the meeting will be held at the Sheraton Towers Hotel in Chicago, Oct. 11-12 (see Chem. Eng., June 12, p. 102). Watch for upcoming details about registration and hotel reservations.*

#### Morning Session, Oct. 11, 1961 Plasma and High-Temperature Chemistry

John L. Margrave, University of Wisconsin

#### High-Pressure Chemistry

Robert H. Wentorf, Jr., General Electric Co.

#### Afternoon Session, Oct. 11, 1961 Solid-State Chemistry

F. Schossberger, Armour Research Foundation

#### Inorganic Complexes

Arthur E. Martell, Illinois Institute of Technology

#### Nonaqueous Chemistry

Joseph J. Katz, Argonne National Laboratories

#### Evening Banquet, Oct. 11, 1961 Speaker to be announced

#### Simultaneous Morning Sessions, Oct. 12, 1961

Morning Session I

#### Chemical Kinetics

Martin Kilpatrick, Argonne National Laboratories

#### Chemical Thermodynamics

Ralph J. Tykodi, Illinois Institute of Technology

#### Catalysis

Vladimir Haensel, Universal Oil Products

#### Morning Session 2

#### Inorganic Polymers

Harold Rosenberg, Wright Aeronautical Development Div.

#### High Polymers

H. F. Mark and S. M. Atlas, Polytechnic Institute of Brooklyn

#### Organic Semiconductors

Herbert A. Pohl, Princeton University

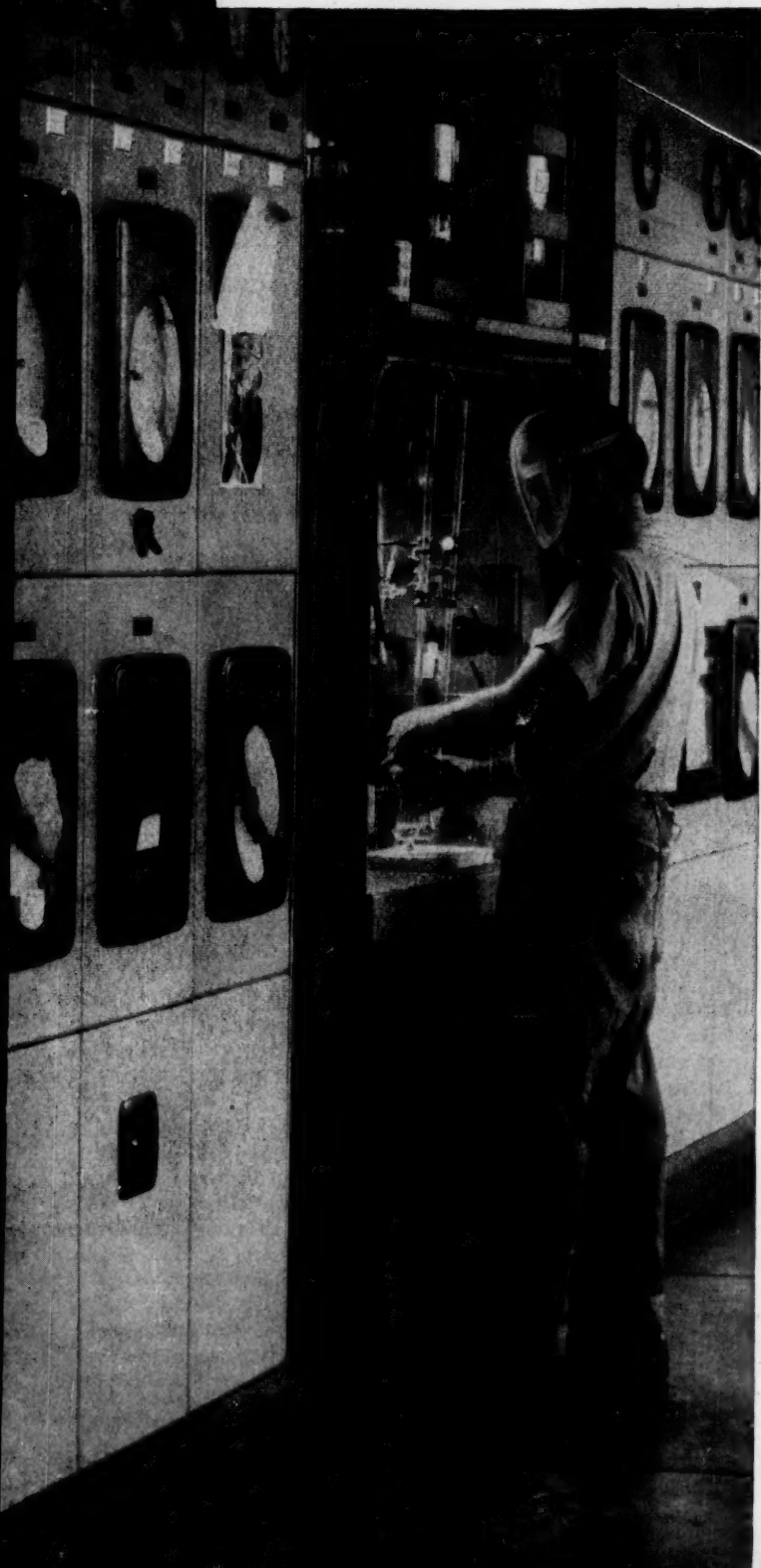
#### Afternoon Session, Oct. 12, 1961

#### Photo and Radiation Chemistry (Speaker to be announced)

#### Ion-Exchange Resins and Membranes

Harry P. Gregor, Polytechnic Institute of Brooklyn





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## CPI News Briefs

- Processes
- Plants
- Offices
- Companies
- International

### Processes

**Fluid-bed ammoniation** of superphosphate eliminates the usual problems of stickiness and corrosion encountered in conventional equipment, reports a recent article in *Chemický Průmysl*, Czech technical journal. Superphosphate was fluidized in a stream of ammonia and air, achieving ammoniation rates higher than in rotating-drum reactors. Capital investment is said to be lower for the fluid-bed system.

Unreacted ammonia from the reactor (about 5% of the original feed) can be passed through a scrubber to react with the dilute sulfuric acid resulting from phosphate rock acidulation.

**New plating process** for depositing bright nickel finishes on a wide variety of base metals has been announced by Metal & Thermit Corp., Rahway, N. J. Called Bright-Nickel 30-W, the plating bath is made up of nickel sulfate, nickel chloride, boric acid and organic addition agents. System is designed to operate at bath temperatures of 120-150 F., pH of 3.5-4.5, and current densities of 20-100 amp./sq. ft.

**Tanning agents** made from spruce bark, which has been a waste product of the pulp and paper industry, have been developed by the Ontario Research Foundation, Toronto, Ont. In laboratory tests, the spruce agents produced leather with properties superior to that treated by vegetable tanning materials. One ton of spruce bark will yield over 500 lb. of the agent.

A new tanning process is also under development, using the dried spruce extract, that could reduce

tanning times to one-tenth of present requirements. It's also said that waste of the tanning material would be substantially reduced, with consequent reduction in stream pollution load.

**Uranium-containing steel** is being produced in test heats at the Algoma Steel Corp., Sault Ste. Marie, Ont. Laboratory tests have indicated that the addition of uranium increases steel's toughness, enhances fatigue resistance and improves corrosion properties. Material is being made in a basic oxygen converter because the flexibility of that process lends itself to the test program.

### Plants

**Olin Mathieson Chemical Corp.** has placed on stream the \$15-million anhydrous hydrazine plant it has built, and will operate, for the Air Force at Saltville, Va. Product will fuel the Titan II booster of the Dyna Soar missile, designed to spurt a man into pilot-controlled earth orbit. Though plant capacity is classified information, facility is known to be highly automated (100 men operate the works). Record nine-month construction was pushed under Olin's three-year, \$25-million Air Force contract.

**Ansul Chemical Co.**, Marinette, Wis., and **Continental Oil Co.**, Houston, announce joint plans for a 60-million-lb./yr. methyl chloride plant at Lake Charles, La., due on stream early next year. Ownership is 50/50, but Ansul—which already makes methyl chloride at Marinette—will be exclusive distributor of the product. In confirming month-old rumors of the petrochemical move, Ansul spokesmen cite demand pressure from TML and butyl rubber makers.

**Heyden Newport Chemical Corp.'s** Heyden Chemical Div. has placed 24 million lb./yr. of maleic anhydride capacity on stream at Fords, N. J.—half a year behind schedule,

thus enabling both Reichhold Chemicals, Inc., and California Chemical Co.'s Oronite Div. to beat it to startup. (Oronite came on stream at Richmond, Calif., with 20 million lb./yr. in April; Reichhold opened its 20-million-lb./yr. unit at Elizabeth, N. J., in May.) Heyden's facility has two interesting features: (1) process itself generates 350-psig. steam, so no boiler house is needed; (2) design permits the production of a host of resin intermediates.

**Western Operations, Inc.**, of Standard Oil Co. of California will construct Alaska's first major oil refinery somewhere on the Kenai Peninsula. Proposal is still in design stages, but facility will probably have a 20,000-bbl./day capacity.

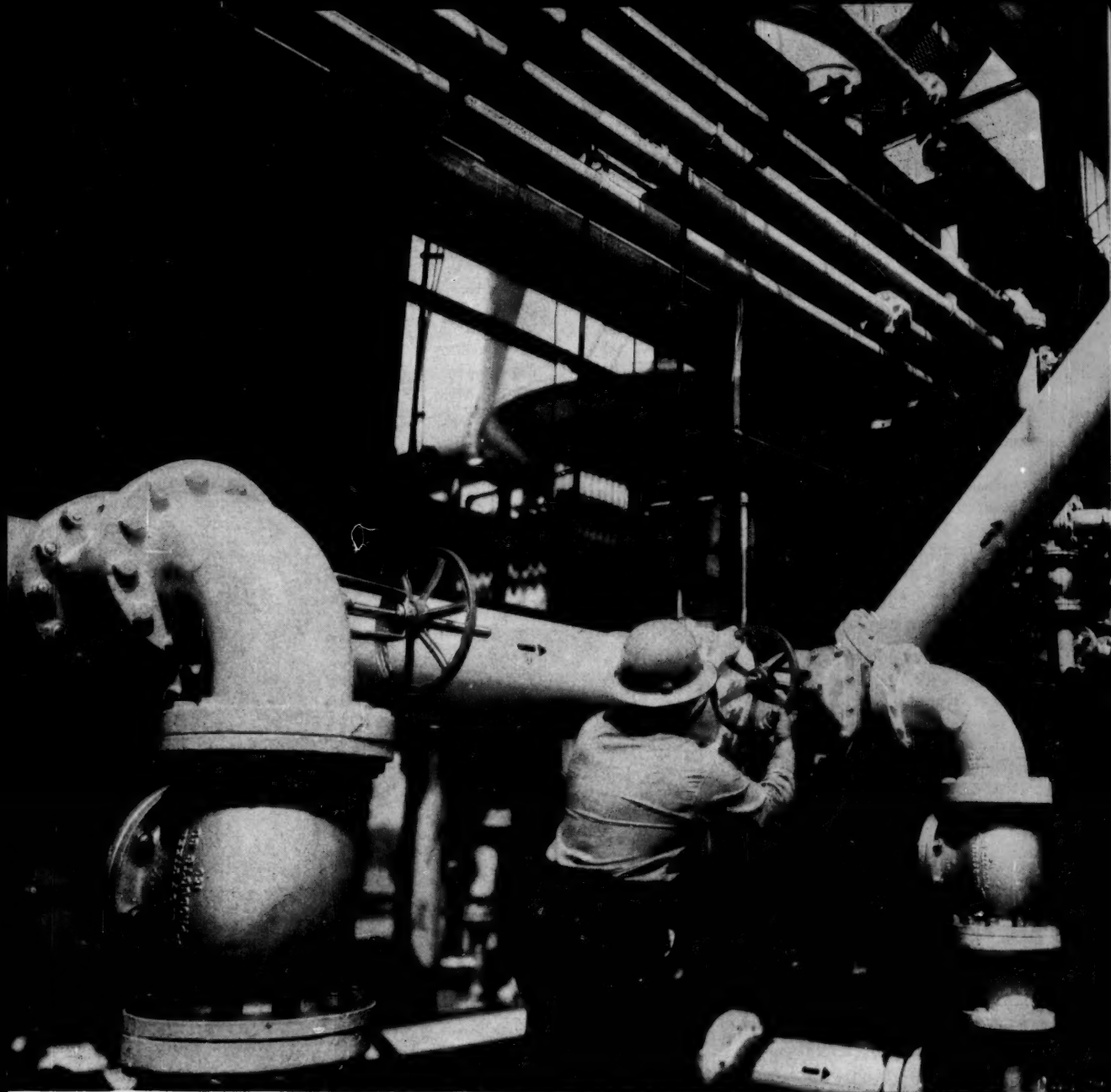
**Nalco Chemical Co.** has picked Freeport, Tex., as the site for its multimillion-dollar alkyl lead plant, currently under design by The Fluor Corp. Planned annual capacity; either 40 million lb. of TEL or 34 million lb. of TML.

**General Electric Co.**, Schenectady, N. Y., has been awarded a \$45,000 contract to build a 1,200-gal./day desalination test-unit for the Naval Academy at Annapolis by July. Type of desalter specified is GE's new "windshield wiper" device (*Chem. Eng.*, Mar. 6, p. 51), in which thin films of brackish, salt or polluted water are literally scraped off the inside surface of a heat-transfer tube. Company believes it possible to extract 42 lb. of fresh water from 100 lb. of sea, but cost estimates await completion of the current test program.

**Allied Chemical Corp.'s** General Chemical Div. schedules July completion for a 50% expansion in hydrofluoric acid capacity at North Claymont, Del. Similar expansion of the firm's Nitro, W. Va., plant went on stream just last year.

**Linde Co.** plans a \$2.5-million expansion of its manufacturing

*CPI News Briefs  
continue on page 160*



## Trouble-free valve performance for 3rd straight year in 98% acid service

These Aloyco valves control the flow of 98% Sulfuric Acid at the three-year-old plant of General Chemical Division, Allied Chemical Corporation at Elizabeth, New Jersey.

They are made from Aloyco 20, a stainless alloy of exceptional versatility. Resistant to a broad range of acids as well as alkalies, valves in this material as produced by Aloyco are first choice in processing plants across the nation.

When you have a corrosive or contamination problem—remember Alloy Steel Products Co. We specialize in Stainless Steel Valves exclusively. Call our local representatives or write us at 1301 West Elizabeth Avenue, Linden, New Jersey.



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## COLLOIDAL ALUMINA TRIGGERS APPLICATIONS SEARCH

*Ionic polymerization reshapes aluminum oxide, promotes its uses in fields as diverse as adhesives, cosmetics, refractories, textiles, paper and catalysis.*

Hatched after several years of research, Baymal is a startling aluminum oxide powder that in one form is hard enough to machine steel and cut glass, while in another, it serves as a base for creamy skin lotions.

Credit for this development goes to Du Pont's John Bugosh, a physical chemistry Ph.D., who discovered that aluminum ions in solution can be polymerized into colloidal particles having a bulk not much larger than organic polymer molecules. Bugosh also learned to control the size and shape of the colloids to such an extent that Baymal now consists of fiberlike particles 1,500 angstroms long  $\times$  50 angstroms in diameter—dimensions that no amount of grinding can produce.

Chemically, Baymal is made up almost entirely (83.1%) of the boehmite form of alumina monohydrate. Also present, and mostly adsorbed on the surface of the particles, are acetic acid (9.8%), water (5.2%) and sulfate ions.

In dry form, this product bears no ionic charge and resembles a fine chalk powder. But in solution, its behavior, appearance and newly acquired properties are in no way reminiscent of chalk.

► **Yields Positive Ions**—In contact with water, Baymal swells and disperses to form a stable colloid that won't settle out as ordinary alumina powder does. The acetate groups, now ionized to negative acetate ions, leave a positive charge on the particles' surfaces. This positive charge can be used to affix the particles to negatively charged surfaces such as acrylic

and polyester fibers, paper, glass and most siliceous materials.

Thus, a monolayer of positive Baymal fibrils provides textile surfaces with antistatic properties, soil and stain resistance, and also improves dyeing and prevents stretching of knit fibers.

► **Films and Coatings**—When the colloidal dispersion has dried on a surface, the small fibrils lie flat and interlock into a thin film, which adheres strongly to the surface

when baked. Presumably, Baymal can therefore be utilized for making high-temperature (starting from 2,000 F.) inorganic adhesives for aluminosilicate fibers, asbestos and glass.

Because of their fibrous nature and small size, Baymal particles exhibit an unusual viscosity in water. The solution can be easily changed from a very fluid state to a pastelike consistency by simply raising the pH to the neutral

### Chemical spray replaces lawn mower

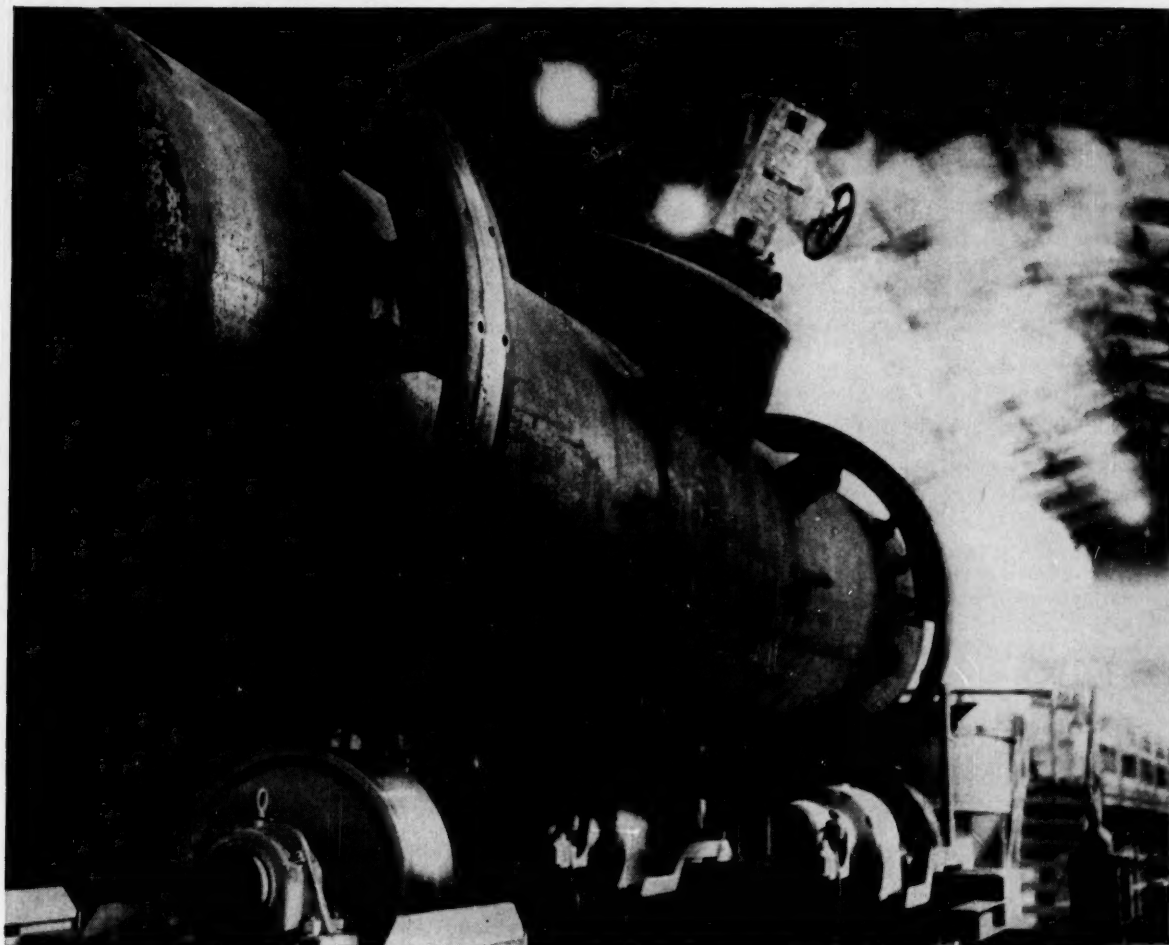


Highway departments in 18 states will soon attack the high cost of mowing roadside grass with a chemical spray. The chemical is MH-30, or maleic hydrazide, a growth retardant that should considerably reduce the \$50 million spent annually in keeping grass neat and trim.

When maleic hydrazide is sprayed on grass, it is absorbed through the blades, then moves through the vein system to the point at which major growth takes place. Here, the chemical blocks the cell division required for upward growth. Frequently, growth impetus then shifts to secondary points, promoting side growth, so that sprayed grass is sometimes thicker and greener than unsprayed grass.

Where slopes have been so steep that power equipment couldn't be used, workers have had to trim the grass with hand scythes. This often has sent the cost of grass cutting to about \$500/acre. But it is estimated that MH-30 can retard the growth of an acre of grass, no matter what the slope, for about \$20.—Naugatuck Chemical Div., U. S. Rubber, New York.

76B



The specialists at General American's Kanigen plant in Sharon, Pennsylvania can deposit an even coating of hard nickel alloy on most ferrous metals in common use. Regardless of how high, wide or heavy the object is, if you can get it to Sharon, we can plate its interior.

Before General American developed Kanigen coating, it was next to impossible to deposit an even nickel plating over very large surfaces or on many complex shapes. Since Kanigen nickel plating is purely a chemical

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NO MATTER WHAT THE SIZE  
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IT CAN BE COATED BETTER  
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process involving no electric current, it works equally well on simple or complex shapes and on small or large surfaces. Thickness uniformity of the coating is independent of part complexity or size.

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Kanigen Division

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point. This thick paste or gel shows the highest thixotropy that Du Pont scientists have ever seen: the gel can be liquefied by shaking, yet will gel again on standing. And Du Pont says it can make solutions that will gel in any desired time, from less than a second up to a day or so.

This thixotropic effect could be used in coatings that can be sprayed or brushed on a wall without dripping, sagging or running; in pigment suspensions such as graphite, mica or clay that will coat surfaces such as metals or ceramics.

Although Du Pont doesn't yet know what practical value such coatings might have, it is possible that electrically insulating or conductive coatings can be prepared in this fashion.

► **Hydrophilic, Organophilic and Hydrophobic**—Positive charge on Baymal particles not only causes them to migrate towards negative surfaces of the material to be treated, but once there, these particles can fix other additional materials to the surface. If an organic fatty acid, for example, is fixed to a modified surface, the coated object is lubricated and is water repellent or hydrophobic. And when a fluorocarboxylic acid is used instead of an ordinary fatty acid, water, oil and stains are repelled.

In addition, Baymal has both hydrophilic and organophilic properties. On the fibrils' surface, there are hydroxyl groups, which are wetted by water, and acetate groups, which are organic and can be wet by oils. These features, Du Pont feels, will prove attractive in the field of cosmetics and emulsions because although there are several surfactants on the market, only a few combine coagulation with emulsification, dispersing and suspending in water and water-alcohol systems.

► **Catalysts and Refractories** — With a surface area roughly equal to 30 acres/lb. (275 sq.m./gm.), the highest for a crystalline alumina, Baymal could be useful as a catalyst base or adsorbent because when heated to 800-900 F. it

forms a porous and reactive alumina.

At still higher temperatures, 2,000-3,000 F., and high pressures, dense alpha-alumina or corundum refractory bodies can be made that are as hard as diamonds.

Although Baymal won't be com-

mercial until its uses have been explored, Du Pont is now producing small lots that are sold at \$3.50/lb. for testing purposes. But lower prices are forecast as soon as commercial production starts.—  
**E. I. du Pont de Nemours & Co.,**  
Wilmington, Del. 76A

## HIGH-TEMPERATURE COATINGS: FILMS THAT FOAM

*Heat makes new paints bubble, forming insulating blankets that keep wall surfaces at 350 F., even when 6,000 F. is applied.*

Three different high-temperature protective coatings have been introduced, all based on the principle of intumescence (i.e., a swelling or bubbling caused by heat). Brushed or sprayed in thicknesses ranging from 0.125 to 125 mils, the three products foam up when heat is applied—keeping temperature beneath the blanket as low as 350 F., while ambient heat goes as high as 6,000 F.

► **PyroShield** is based on a ternary system of ammonium phosphate, an undisclosed amine and a polyhydric alcohol. Stable at room temperature, the chalklike powdery mixture is dispersed in an oil carrier. Add water, and a viscous liquid is formed; like paint, it can then be sprayed, brushed or dipped (in recommended 40-mil thicknesses).

As ambient temperature rises to 300-400 F., the ternary system establishes new equilibrium plateaus by liberating free  $\text{NH}_3$ , which swells the coating by bubbling through it. Fire can't reach the coated object or wall because PyroShield takes temperatures of 2,000 F. for over an hour, keeping temperature of the protected surface under 350 F. Heats of 5,000 F. have been withstood for shorter periods of time.

Two formulas are available:

Type 21 is sold as a powder, Type 33 as a predispersed liquid (at \$25/gal. for 60%-solids content). Former can be water-washed from surfaces when the job is done, but later type is permanent and hence can be applied as a fire-retardant primer coat beneath conventional decorative paints (especially, for example, in working areas around welding operations, where sparks as well as overheating are potential fire-starters; and for process vessels containing hazardous chemicals, where a subcoat of PyroShield would protect against overheating.—**Columbia Technical Corp.,** New York. 78A

► **Dyna-Therm D-65** is also a ternary system, though company identifies it only as "containing phosphates and boron flameproofing chemicals dispersed in a flexible polyurethane binder."

Like PyroShield, Dyna-Therm D-65 foams when heated. Tested on the Atlas missile, 0.125-mil coatings protected surfaces from 6,000-F. ambient temperatures. In some instances, original coating remained serviceable for more than one heat exposure. Disadvantage: selling price of \$98/gal.—**Dyna-Therm Chemical Corp.,** Culver City, Calif. 78B

► **Hel-Met 1050**, third of the new products, is described only as an intumescent material composed of ammonium phosphates and "borates in a modified alkyd vehicle." It begins to foam at about 325 F., carbonizes at close to 400 F.

In flame tests, the carbonaceous mat kept its underside at 375 F., while ambient heat went to 1,700 F.; more spectacularly, it with-



# Here's Why Oil Men Specify EC&M HIGH VOLTAGE STARTERS

2200-4800 Volts  
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EC&M Type ZHS  
Starters at Southwestern  
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**Designed for Easier Installation,  
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Specifically designed for Class I, Group D, Division 2, semi-hazardous locations... NEMA 3R (raintight enclosure). 50,000 KVA interrupting capacity.



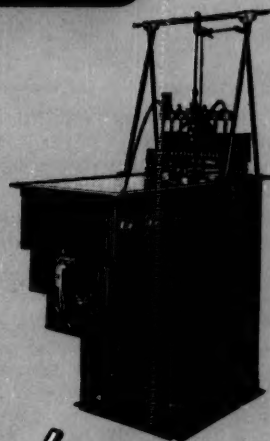
Fast installation because starters are shipped with all internal wiring complete. All leads are of anti-syphon construction.



Easy inspection • Contactor and overload relay panel may be raised, as one unit, above oil level. No disconnecting of bolts or leads. (See lifting mechanism at extreme right.) Safer, too...note view windows on each side of load-break disconnect switch.



View from above shows complete internal wiring...anti-syphon leads. These "ready-to-use" starters are complete with control transformer for 220 volt push button operation.



EC&M Contactor lifter raises contactor and overload relay above oil level for easy inspection. No bolts or leads to disconnect.

For literature describing EC&M's complete starter line, write for Bulletin 8131-T



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stood 5,500 F. at Mach IV velocity.

Unlike the other two coatings, Hel-Met 1050 comes in a variety of colors, can be thinned with mineral spirits and applied to plaster walls as well as metals, cellulose, etc. Thickness of spread depends on the type of application: in some cases, two coats are needed—making the film as deep as 125 mils ( $\frac{1}{4}$  in.).

Hel-Met 1050 demands 48 hours to reach maximum fire retardancy. However, balancing both this and its thickness: it cost only \$6/gal.—**Empire Coatings and Chemical Co., Denver, Colo.** 78C

### Vinyl ether copolymer

**Copolymer of methylvinylether and maleic anhydride has myriad uses.**

First of a planned family of vinyl ether polymers and copolymers, Gantrez An is a copolymer of methylvinylether and maleic anhydride. Now available in semi-commercial quantities at \$1.25/lb., the versatile resin is seen to have specific applications in adhesives, textiles, detergents, latex polymerizations, and a host of other areas.

A free-flowing white powder, the resin is water-soluble over full pH range (though crosslinking with a polyol or polyamine makes it insoluble—and hence attractive as a soluble binder that needs only to be heated to turn insoluble). Aqueous solutions are good thickeners and protective colloids, and don't salt out; the free acid, half amides, partial or full esters, and crosslinked anhydride variations

are all effective film-foamers and thickeners in diverse solvent and emulsion systems.

Deposited from aqueous or organic systems, unmodified Gantrez An films are reported as clear, tackfree, highly polar and have high cohesive strength in bonds to glass, plastics, metals, cellulose, rubbers. The copolymer also makes a good compounder for remoistenable, pressure-sensitive binders.

Partial list of other suitable uses: textile finishing agent; fiber modifier; colloidal suspending agent for synthetic latexes; emulsifier and particle-size regulator in emulsion polymerization of acrylics and vinyls; thickener and coater in photopolymerization of diazo, dichromate, and silver halide systems.—**General Aniline & Film Corp., New York.** 80A

### Phenolic resins

**Silicon- and polyamid-modified phenolics make heat-resistant laminates for use in missiles.**

By impregnation of glass cloth, two new phenolic resins can yield high-temperature laminates that resist ablation and fires.

The first, called Plyophen 23-017, is a phenolic-silicone resin in isopropanol solution (about 65% solids), which claims a burn-through resistance at 600 F., superior to that of epoxy-modified phenolics. The other Plyophen 23-057, consists of a polyamid-modified phenolic in a water-ethanol solution (about 45%

solids), which yields laminates that can be exposed to above 6,000 F. for short periods of time.

Although both resins have given satisfactory results with glass cloth, they can still be improved with certain fillers such as aluminum phosphate, graphite or short fibrous asbestos. These fillers can be incorporated in amounts up to 10%, or higher, especially when exposure temperatures are high.

After cure, both resins have a flexural strength of about 76,000-79,000 psi. at room temperature, which gradually decreases to about 18,000-17,000 psi. after exposure temperatures go up to about 900 F.—**Reichhold Chemicals Inc., White Plains, N. Y.** 80B

### Briefs

**2,6-dimethoxyphenyllithium**, now available in sample quantities, is a white-tan, free-flowing powder known to react with aldehydes and ketones to form secondary and tertiary alcohols. Other reaction: it changes nitrile groups to carbonyls, and forms amides from isocyanates. Because of its fair solubility in hydrocarbons, it can be useful as catalyst in stereospecific polymerizations of butadiene-styrene rubbers.—**Lithium Corp. of America, New York.** 80C

**Benzidine yellow pigment** is now produced in a grade that features low oil absorption and low viscosity. Identified as Rangoon Yellow Toner 73 T 51, the new pigment should enable ink manufacturers to obtain formulations of high strength coupled with low viscosity—two desirable properties that are difficult to attain with ordinary types of benzidine yellows.—**Ans-bacher-Siegle Corp., Staten Island, N. Y.** 80D

### —Newsworthy Chemicals—

#### Page number is also reader service code number

Colloidal aluminum triggers a search for applications.....	76A
Maleic hydrazide spray keeps lawns neat and trim.....	76B
Protective "paint" foams up, keeps temperature down.....	78A
High-temperature coating turns into foam, stops heat.....	78B
Intumescent coating is third "film that foams".....	78C
Vinyl ether copolymer is versatile new resin.....	80A
Phenolic resins make heat-resistant laminates for missiles.....	80B
2,6-Dimethoxyphenyllithium turns isocyanates into amides.....	80C
Benzidine yellow pigment has low viscosity, oil absorption.....	80D

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# LOOK TO POWELL VALVES

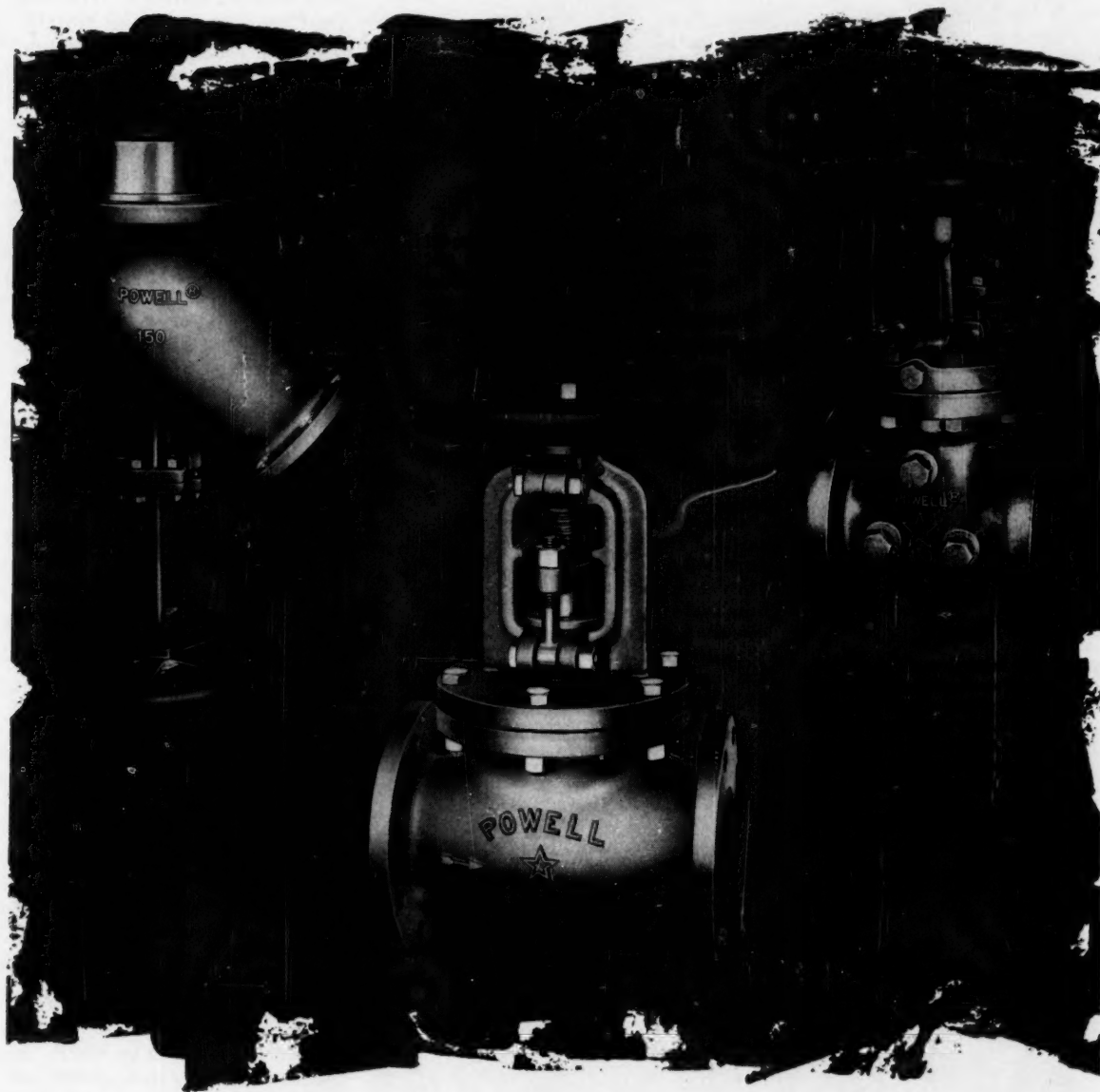
You can count on Powell Valves for the answer to virtually any flow control problem where corrosion, erosion, temperature, or pressure are encountered. Because, at Powell, you'll find the largest selection of valves for the chemical industry.

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#Registered trade name of Haynes Stellite Company.



*115th year of manufacturing industrial valves for the free world*

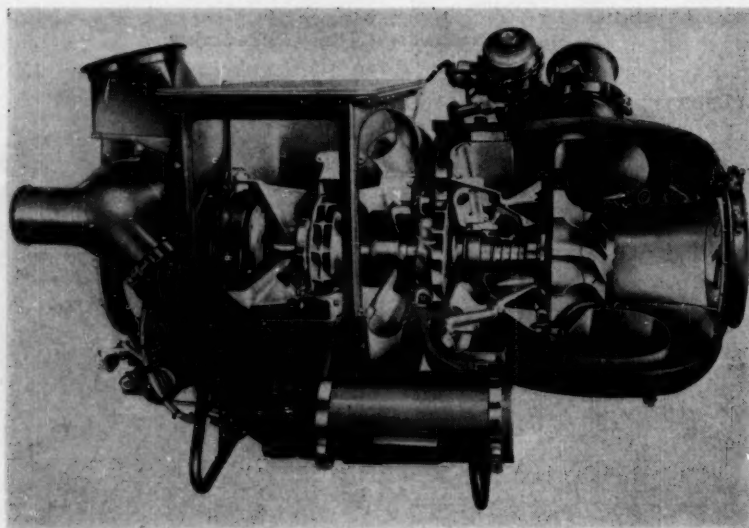
**POWELL CORROSION RESISTANT VALVES**

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

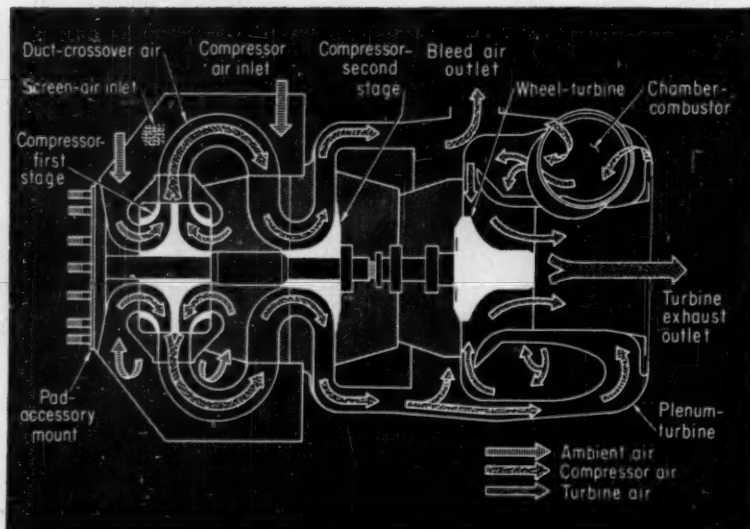




## GAS TURBINES PROVIDE PUSHBUTTON PACKAGED POWER



Turbine unit (above) produces energy in the form of both compressed air and shaft horsepower. Packaged and skid-mounted, turbines can provide from 30 to 850 hp. for various applications. Flow chart (below) depicts air movements through turbine, during regular operating cycle. Exhaust gases are normally heat-exchanged with incoming combustion air to increase the efficiency of the unit to the maximum.



*Compact units compete with piston-based power, where portability, quick starts and light weight must be considered for compressed-air and shaft-power needs.*

Power in a hurry is promised by a new line of packaged gas turbines. Ranging from 30 to 850 hp., the units are said to start dependably and quickly under conditions of extreme heat or cold, heavy dust or sand. And they attain peak efficiency in a matter of seconds.

Packaged by Mission Mfg. Co., the equipment is built around a variety of turbines made by AiResearch Mfg. Co. of Arizona, a division of Garrett Corp. The 30-hp. unit is said to be the smallest packaged turbine offered as standard equipment.

Three general types of turbines are used in the packages. Energy can be furnished in the form of compressed air, as shaft power, or as shaft power and compressed air simultaneously. Skid-mounted for easy transport to place of use, the basic package contains a heat exchanger, operating controls and safety devices, in addition to the turbine.

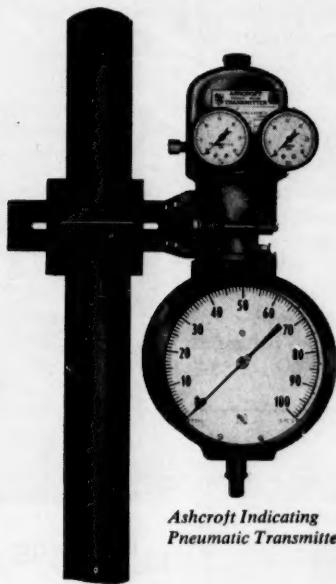
Units are equipped with an automatic control system that sequences starter operation, fuel control and ignition. Operation of a single switch initiates the cycle. ► **It's a Heat Source**—Applications for the packaged turbines are varied. They can furnish heat from 10,000 to 100,000 Btu./min. in free-flowing air at up to 950 F., or compressed air from 90 to 500 F. As compressors, they can provide air at 30 to 350 psi. for sand blasting, rock drilling, or other services where constant or intermittent supplies of air are needed.

Furthermore, the turbines can be used as peak- or emergency-power generator drives, or to pro-

# signal

**ASHCROFT PNEUMATIC TRANSMITTERS** give you  
a true primary and transmitted signal for indication or control

# action



*Ashcroft Indicating  
Pneumatic Transmitter*

Now—detect with precision accuracy the slightest change in primary pressure or temperature. Transmit this signal quickly to your indicators or controllers. Ashcroft Pneumatic Transmitters do the job at lowest initial and operating costs.

Full-range, solid-front indicating and totally accessible nonindicating transmitters need no costly high-pressure lines, yet permit complete monitoring of processes in remote areas. For safety's sake, you get full indication even if the air is shut off.

Narrow-span Ashcroft Transmitters are expressly designed with highest sensitivity and repeatability for the most accurate primary sig-

nal feed to controllers. You get better control and purer, lower-cost final products.

Only in Ashcroft Pneumatic Transmitters can you get the wide choice of Ashcroft Duragauge Bourdon tubes or American mercury or gas-actuated sensing systems. You also get a time-proven, obstructionproof, force-balance, non-bleed replay for economical, maintenance-free 3-15 psi or 3-27 psi signal transmission. Both indicating and nonindicating *suppressed* types available.

Write for factful Bulletins 360 and 361 or ask your nearby Ashcroft Distributor to help you select the right transmitters and receiver gauges.



## **ASHCROFT PNEUMATIC TRANSMITTERS**

**A product of**

**MANNING, MAXWELL & MOORE, INC.**

*Gauge and Instrument Division • Stratford, Connecticut*

*Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario  
Latin America: Export Division, Chrysler Building, New York, N. Y.  
Europe: Manning, Maxwell & Moore, S. A., Fribourg, Switzerland*

vide immediate power for pumps on fire protection systems.

► **Pro and Con**—Principal advantages of the turbine unit are its light weight and compactness, ability to operate on a wide variety of fuels, ease of starting under extreme conditions, and feature of attaining best performance when running constantly at maximum speeds.

The turbine has a minimum of moving parts, requires no cooling water and very little lubrication. And it's much more portable than a reciprocating unit, which requires heavy foundations and more utilities.

On the other hand, the high temperatures involved require expensive alloys as construction materials, and the high speeds attained necessitate precision fabrication techniques. In addition, turbines drink twice as much fuel as reciprocating engines. — **Mission Mfg. Co., Houston.** 82A



### Pressure regulator

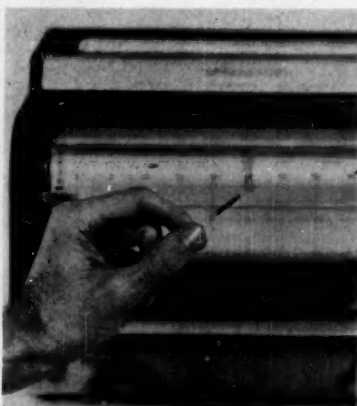
**Sensitive unit said to control with swing of only  $\pm 0.1$  psi.**

Pressure regulation equal to that obtained with piloted valves, without the trouble associated with pilots, is claimed for this pressure regulator that controls downstream pressure in the range from 0.5 to 125 psi.

Available in ductile iron or

bronze, the unit comes in  $\frac{1}{4}$ ,  $\frac{3}{8}$ ,  $\frac{1}{2}$  and 1-in. sizes for service with steam, air, water, oil, gas or chemicals. Sliding-gate seats, self-cleaning and self-lapping, provide tight shutoff.

Suitable for 250 psi. at 500 F., regulator controls within 0.1 psi. for 10-15 psi. pressure differential, within 0.5 psi. for 90-100 psi. difference. Pressure drop range is 3-175 psi.—**OPW-Jordan Corp., Cincinnati.** 84A



### Cryogenic thermometer

**Germanium thermometer, special recorder report low temperatures.**

A system for measuring cryogenic temperatures depends on a germanium thermometer and a special potentiometric recorder.

Available in three versions (calibrated, uncalibrated and standardized), the thermometers are said to offer fast response, good reproducibility and dependability during continuous cycling to room temperatures. Nonmagnetic, probe has desirable low-temperature properties.

The recorder, an integral part of the measuring system, can be converted to standard d.c. recording.

Two systems currently offered give readings in the 1-40 deg. K. range and the 18-28 deg. K. range (liquid hydrogen). Special systems are available for specific requirements.—**Texas Instruments, Inc., Houston.** 84B

### Solids flow meter

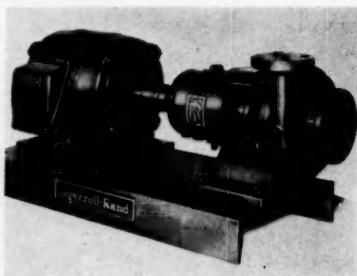
**Vane converts material's velocity into measurable rotary motion.**

Total flow of granular material such as coal, ore, crushed rock or chemicals is measured with a solids flow meter that can be used with ducts, pipes or spouts up to 40 in. in diameter.

Velocity of the flowing material is converted into rotational speed by a helical quarter-turn vane that is centered in the pipe or duct. Rotary motion, transmitted from the pipe at a 90-deg. angle to the flow of material by means of a flexible shaft and a set of change gears, operates either a direct mechanical counter or an electric contact mechanism connected to a remote counter.

Two different vanes are used, depending on pipe size: 8-in. dia. for pipes to 20 in., and 16-in. dia. for larger pipes up to 40 in. Spacers in the meter assure that the vane is always centered.

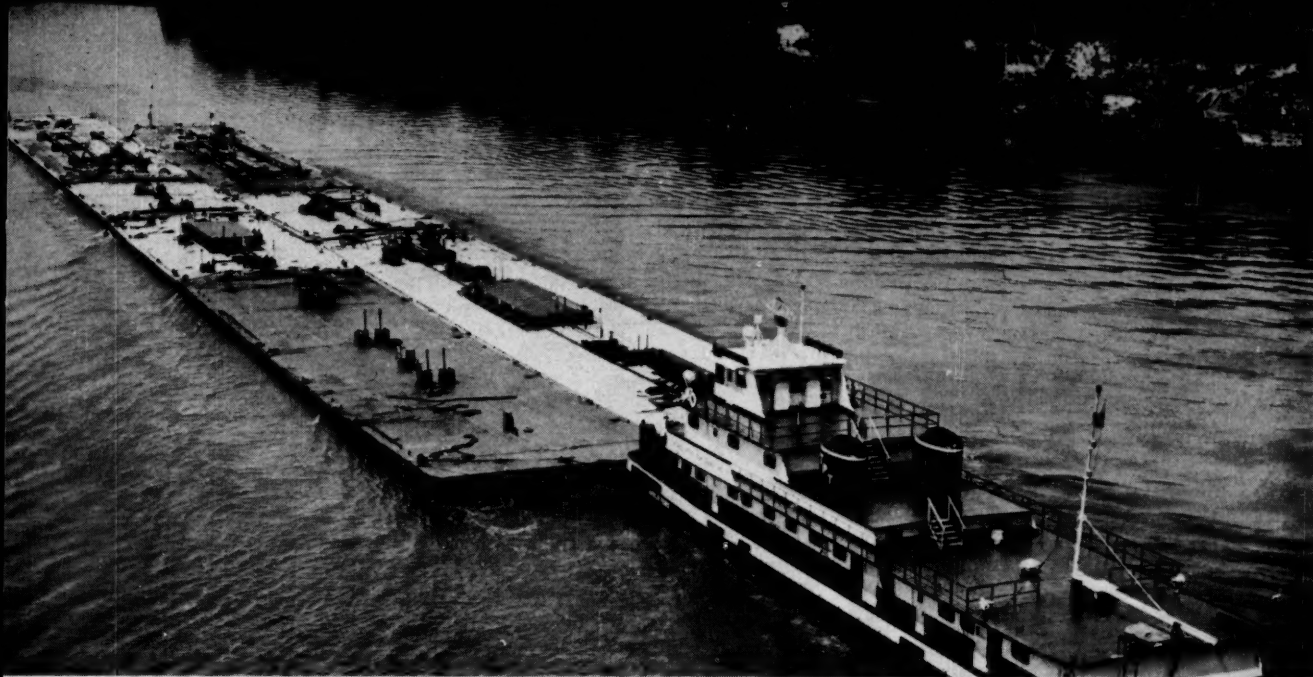
To prevent solids from working into the bearings, an air purge is provided; consumption is less than 0.1 std. cu. ft./min. at 5-psig. supply. Bearings are said to be capable of operating at 10 rpm. for approximately 50,000 hours.—**Bailey Meter Co., Cleveland.** 84C



### Centrifugal pump

**General-service unit can handle ordinary or corrosive liquids.**

Featuring interchangeability of parts, in pumps of the same size, a new line of cradle-mounted centrifugal pumps is available in ferrous and nonferrous alloy materials. Three models, ranging from



Shell has three benzene-producing refineries, located near waterways. Barges like these will carry the bulk of 1961's record output.

## **BULLETIN:**

**Shell has increased benzene production  
to meet your rising needs—capacity now exceeds  
80 million gallons per year**

Shell has increased its benzene production nearly 500 percent in less than 18 months. Shell's benzene-producing capacity in the U. S. is now the largest in the world.

Shell's stepped-up output comes to you via a nationwide supply network served by 3 refineries.

Read how Shell's increased benzene production can help you meet your rising benzene requirements now.

**W**ITH DEMAND for benzene at an all-time high, and with new uses coming along each year, Shell is producing more benzene now than ever before.

### **Bigger supplies now**

Shell has stepped up production of benzene again. Shell's capacity has already topped 80 million gallons of high purity benzene. *And Shell has nationwide facilities for producing*

*and distributing benzene.*

### **Widest distribution**

Shell Benzene is produced at three refineries. At Wood River, Illinois; Houston, Texas; and Wilmington, California.

**NOTE:** All three refineries are located near waterways. You can take delivery of Shell Benzene in barges, in tank cars and transport trucks. Deliveries can come direct from the refinery.

Manufacturers choose Shell Benzene when precise control is vital. Its quality is consistently high.

*And it is free of Thiophene.*

For full facts on Shell Benzene, contact your Shell Industrial Products Representative. Or write: Shell Oil Company, 50 West 50th Street, New York 20, N. Y.




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**A BULLETIN FROM SHELL**  
—where 1,997 scientists are working  
to provide better products for industry

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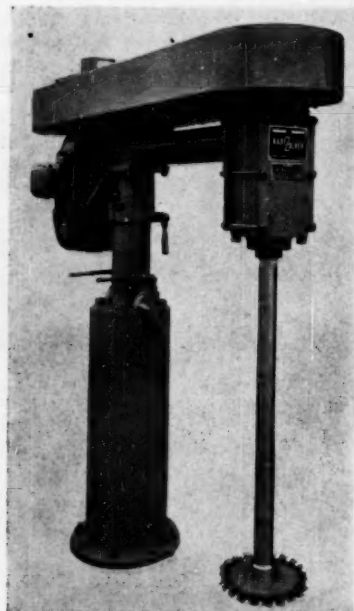


## NEW EQUIPMENT . . .

$\frac{1}{2}$  through 50 hp., furnish up to 1,000 gpm. at heads to 240 ft.

Pump casings are of vertically split design, with flanged suction and discharge connections, standard or water-cooled stuffing box construction. Maximum liquid temperature of 250 F. on standard unit is boosted to 400 F., if water cooling is used.

Designed primarily for horizontal operation, pump's discharge nozzle can be normally rotated to any one of four positions. Unit may be driven through a flexible coupling, gear, or belt and sheave arrangement.—Ingersoll-Rand Co., New York. **84D**



### Variable-speed mixer

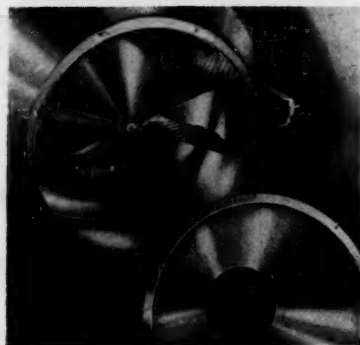
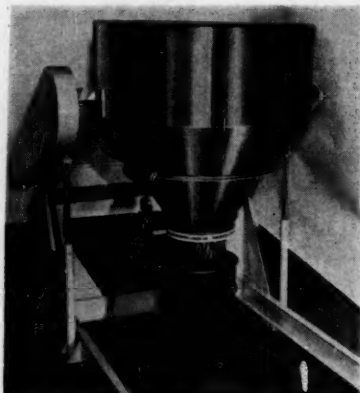
Speed and elevation of rotor are controlled from single station.

For deagglomeration, emulsification and dispersion, this mixer has a 45-in. blade elevation and a 28-in. clearance at any point in a 360-deg. arc around the central column.

Speed and elevation are controlled from a single point on the central oil pedestal. Rotational locking is said to be accomplished by a unique system that eliminates

exterior steadying pipes, supports.

Built to use 10-25-hp. motors, the unit has a stainless steel shaft and impeller.—Kinetic Dispersion Corp., Buffalo. **86A**



### Solids mixer

Slotted internal screens provide infinitely varied flow patterns.

Mounted radially on a fixed cone at the base of a mixing drum, screens enhance particle association and provide gentle mixing. They contain thousands of slots, set up an infinite number of flow patterns for each revolution.

Mixer is said to be able to effectively blend particles of different weight and specific gravity. Slotted

For more information about any item in this department, circle its code number on the Reader Service Postcard (Page 185)

screens with openings from  $\frac{1}{8}$  to  $\frac{1}{2}$  in. are available for a wide range of particle sizes.

For loading and unloading at floor level, the unit is provided with a raising and lowering device that operates hydraulically. Construction is welded stainless steel for handling abrasive, corrosive and sanitary materials. A bench-scale unit is used to evaluate performance on untested materials.—Hobam, Inc., Buffalo. **86B**

### Priority relief valve

Unit operates at absolute system pressure rather than differential.

Operating at pressures to 2,000 psi., a priority relief valve closes under strong spring action whenever the downstream pressure drops below design closing pressure. Above preset pressure, valve is fully open, permitting flow with virtually zero pressure drop.

With this valve in the system, the primary portion of the piping circuit is protected against withdrawal of pressure by auxiliary systems that would jeopardize proper functioning or safety of the primary system.

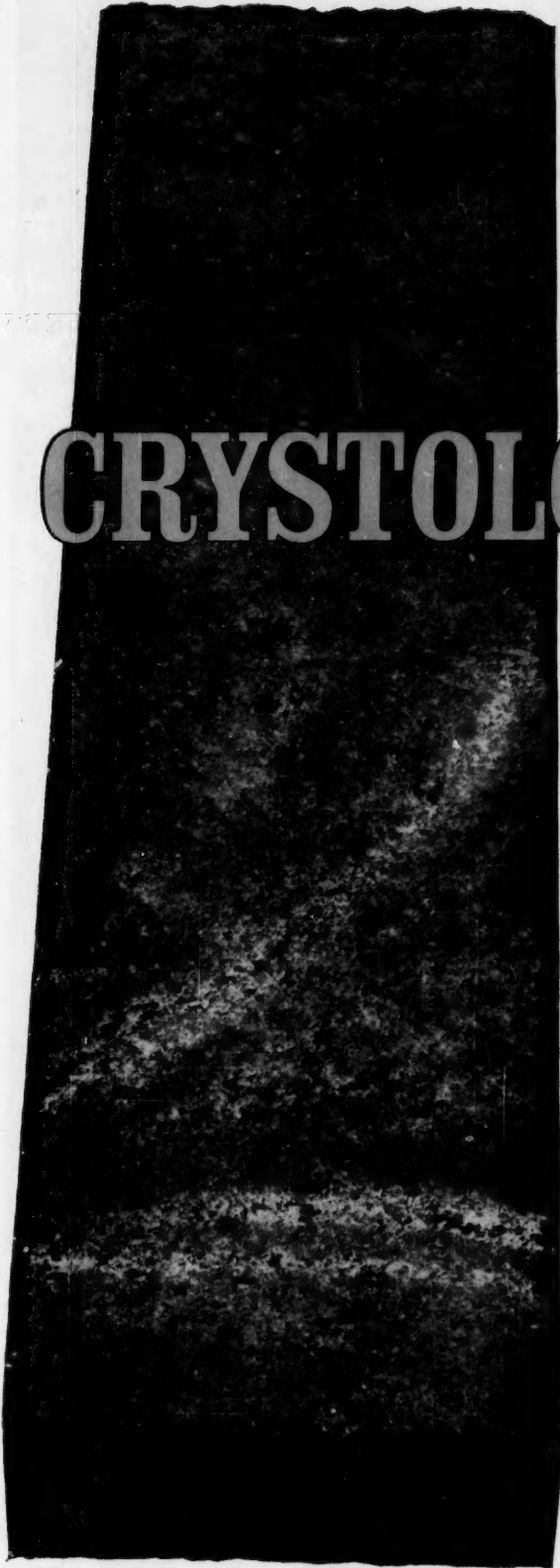
Positive spring pressure opens and closes valve smoothly without sticking or galling, according to the manufacturer. O-rings provide the seal.—Circle Seal Products Co., Inc., Pasadena, Calif. **86C**

### Vibrating screen

Balanced decks eliminate need for dead weight counterbalances.

Vibrating screen or conveyor decks are balanced one against the other in a new unit that also features a suspension system said to eliminate vibration from the frame. Screen decks are supported on the base, exactly in their center of oscillation, and therefore transmit no vibrations.

*New Equipment continues on page 174*



*Now...a low-cost  
Nitride-Bonded  
Silicon Carbide!*

# CRYSTOLON<sup>\*</sup> "63"

Now, the best-performing silicon carbide refractory is available at a realistic price! Brand-new CRYSTOLON "63" permits the use of a cost-saving nitride-bonded silicon carbide refractory for hundreds of applications.

Produced by an exclusive Norton process, CRYSTOLON "63" silicon carbide provides all the superior properties of nitride-bonded silicon carbide at a *new low cost!* It has high thermal conductivity, excellent heat shock and wear resistance, and good resistance to most corrosive liquids. In extensive tests, it not only showed excellent resistance to "wetting" by molten non-ferrous metals (aluminum, magnesium, zinc, lead and others) but also to fused salts, such as cryolite!

Use CRYSTOLON "63" silicon carbide as a refractory for handling corrosive salts — as reactor lining — as the *economical* solution to hundreds of tough processing problems. Get complete test results and properties now. Write NORTON COMPANY, Refractories Division, 505 New Bond Street, Worcester 6, Mass.

\*Trade-Mark Reg. U.S. Pat. Off. and Foreign Countries



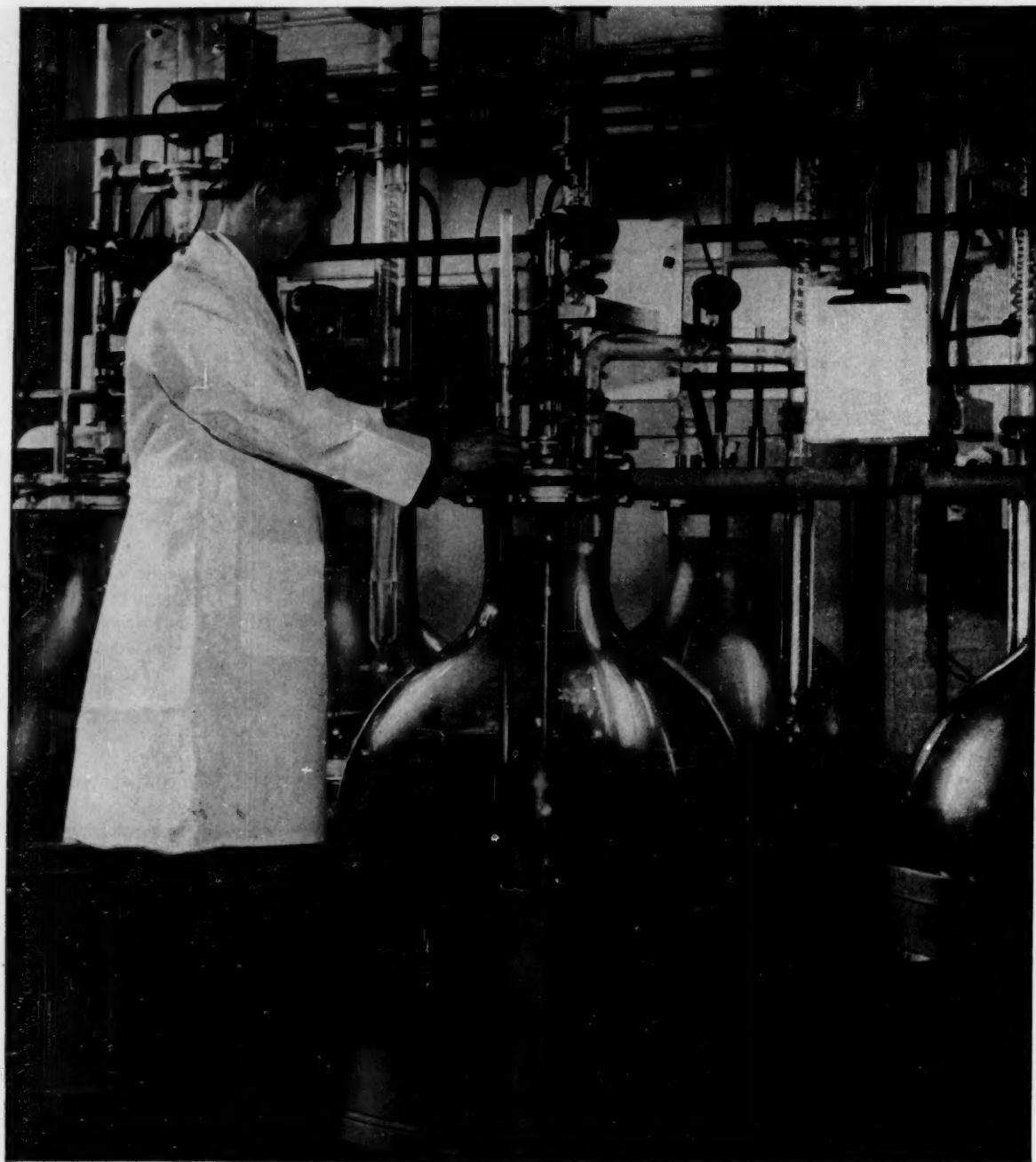
**REFRACTERIES**

*Engineered... R... Prescribed*

*75 years of*

**Making better products  
...to make your products better**

**NORTON PRODUCTS:** Abrasives • Grinding Wheels • Machine Tools • Refractories • Electro-Chemicals — **DEHN-MANNING DIVISION:** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes



**Heating mantles by Glas-Col make the production scale all-glass plant a safe and practical operation.** *Example:* Here at Hoffmann-La Roche, Inc., Nutley, New Jersey, high purity pharmaceuticals are being produced in giant 200-liter flasks heated by six Glas-Col heating mantles. They have been in round-the-clock service for several months. Glas-Col has pioneered in the development of safe, dependable electric heating mantles for every use. Ask for bulletin or tell us your specific heating problem. Information on all-glass plants can be obtained from Corning Glass Works. For heating mantles . . . Glas-Col, of course.

**Glas-Col Apparatus Company /** *Dept. CR, 711 Hulman St., Terre Haute, Indiana*

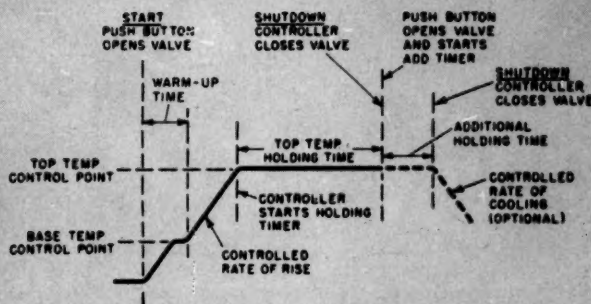
Trademark Registered U. S. Patent Office. U. S. Patents . . . 2,282,078 . . . 2,739,220 . . . 2,231,506 . . . and 2,739,221

# "Push-button" automatic control for complex time-schedules!

• no cam to cut

• schedules reproduced exactly by push button

• schedules changed instantly by turn of knob



With the Foxboro CycleLog Controller you can establish intricate control programs for process variables with a "twist of the wrist" . . . change them just as easily! You merely "dial" starting point, rate of increase to holding point, holding time, and rate of decrease to shut-down. A push button starts automatic control of cycle . . . repeats it precisely, as often as desired.

Such bothersome industrial control problems as simple batch polymerizations, dissolvers, rubber processing (to name just a few) are being solved every day with this compact, flexible system. No more spoiled batches, "off-spec" product, or expensive re-runs. Operators report better quality, better uniformity, and increased production. And it all adds up to more efficient, profitable manufacturing.

Your nearby Foxboro Field Engineer will be glad to discuss, at your convenience, how CycleLog Control can be used to advantage on your processes. Why not give him a call, or write today for Bulletin 5A-12. The Foxboro Company, 366 Neponset Avenue, Foxboro, Massachusetts, U.S.A.

## FOXBORO

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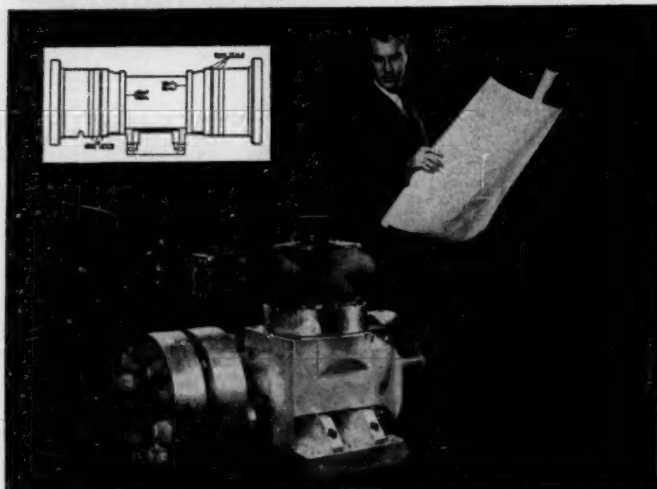
pneumatic instrumentation





THE RAW MATERIALS OF PROGRESS

## No part too large or complex for corrosion protection with KEL-F® Dispersion coating BRAND



The five-ton valve above is used to test a rocket engine fuel line. Its flow valve meters a highly corrosive mix—liquid oxygen and kerosene fuels—at temperatures below  $-300^{\circ}\text{F}$ . and pressures up to 5,000 lbs. psi. Yet valve leakage in this precision assembly is zero. And the designer credits corrosion-blocking KEL-F Brand Dispersion coating on valve seat rings and seals, at eight critical points (see diagram above).

Parts and surfaces too large

or intricate to fabricate from a molded plastic can have the benefits of halofluorocarbon protection with KEL-F Dispersion. First you spread, spray or dip coat it. Then with heat application KEL-F coating fuses into a tough, adherent, continuous coating with extreme resistance to corrosive chemical attack at a wide temperature range. (See "profile," right). For further information and design data, fill out coupon below . . .

3M Chemical Division, Dept. KAL-61  
3M Company  
St. Paul 6, Minn.

**TELL ME MORE...**  
about KEL-F Dispersion coating

Name \_\_\_\_\_  
Title \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
City & State \_\_\_\_\_

### PROPERTIES PROFILE

ON

#### KEL-F Dispersion coatings BRAND

KEL-F Dispersions were developed to extend the protection of KEL-F Plastic to the surfaces of parts that do not lend themselves to fabrication from molded plastics because of size, design or construction. Consisting of fine particles of KEL-F Plastic suspended in a volatile organic liquid, KEL-F Dispersions can be applied to many metallic and certain non-metallic surfaces by spray, spread or dip coating. Heat fuses the dispersion into a tough, permanent protective coating with high tensile and compressive strength, good elongation, and excellent abrasion and wear resistance.

TYPES OF DISPERSIONS	Type KF-625	Type KF-602
Application Method	Spray	Spread, flow, dip
Pounds solids per gallon	3.6	3.4
Approximate square foot coverage per gallon (per mil thickness)	295	330
Viscosity, Zahn G-1 Cup, $75^{\circ}\text{F}$ . secs.	34	—
Viscosity, Brookfield, $75^{\circ}\text{F}$ . cps.	—	9-10,000
Thinners	Xylene	Amyl Acetate

#### PROPERTIES

**Chemical resistance.** KEL-F Dispersion coatings resist attack by strong acids, alkalis, gases and oxidants and extremely high temperatures. This makes them outstanding corrosion protectors for aerospace equipment.

**Anti-stick characteristics.** Glues, inks, paints, greases, waxes, rubber or casting resins will not readily adhere to coatings of KEL-F Dispersions. Coating surfaces of aerospace equipment with KEL-F Dispersions reduces clean-out and shut-down time.

**Temperature resistance.** Temperature-resistant KEL-F Dispersion coatings have an operational range of  $710^{\circ}\text{F}$ . ( $-320^{\circ}\text{F}$ . to  $+390^{\circ}\text{F}$ .).

**Dielectric strength.** KEL-F Dispersion coatings have high dielectric strength at low to very high operational frequencies and temperatures. Non-wetting surfaces permit no moisture absorption, minimize flashover.

For full information on KEL-F Halofluorocarbon Dispersion coating systems, send for our brochure on the subject, or write, describing your area of interest to 3M, Chemical Division, Department KAL-61, St. Paul 6, Minnesota.

**MINNESOTA MINING AND MANUFACTURING COMPANY**

... WHERE RESEARCH IS THE KEY TO TOMORROW



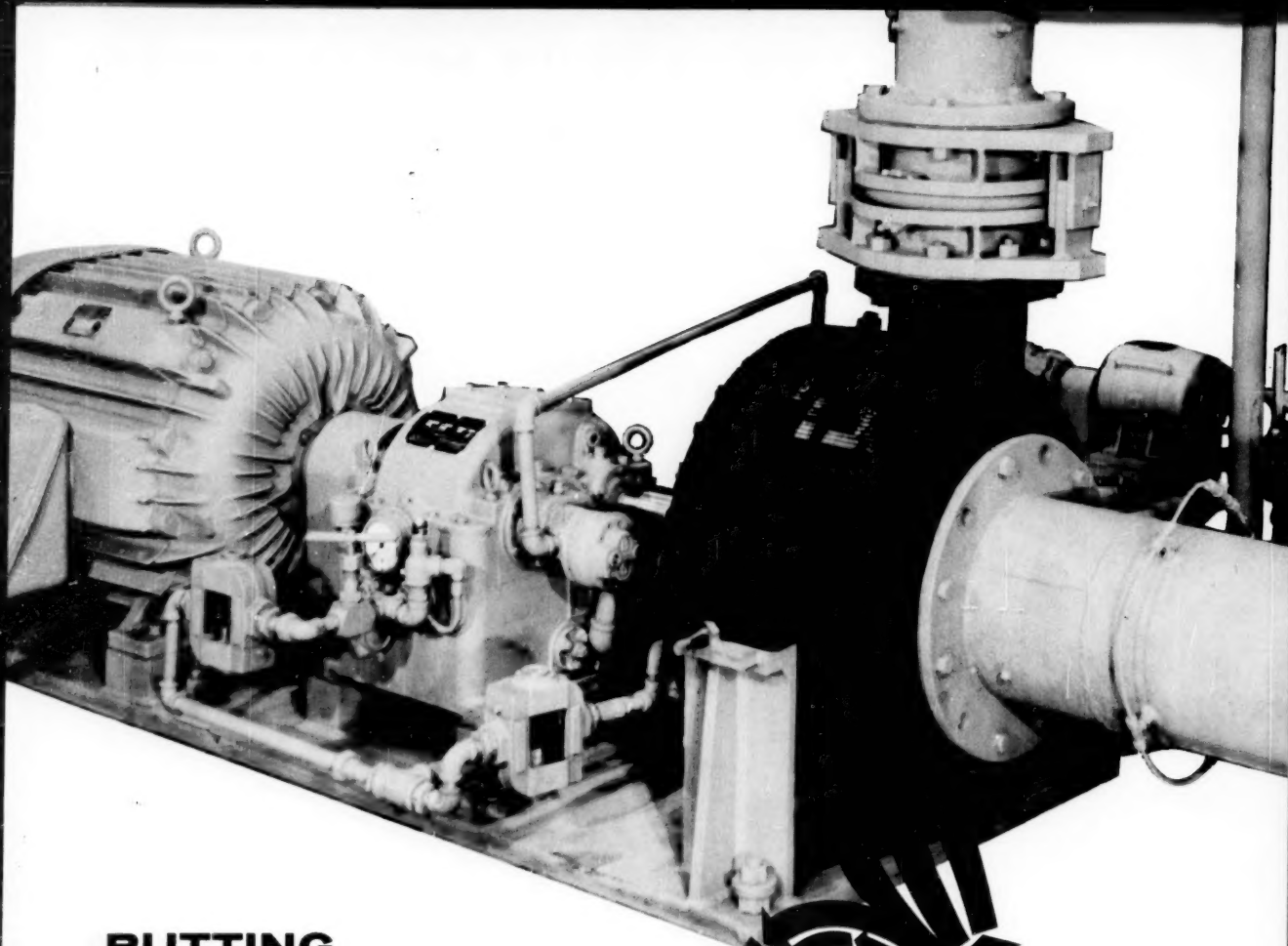
# INDUSTRY'S MAGIC WHEEL

This is an open radial impeller . . . the heart of the Elliott H-line centrifugal compressor. The H-line compressor will

- do more work ■ handle more gases
- serve more applications than any conventional design. It permits dramatic reduction in compressor size and weight, facilitates Iso-cooling, and extends the advantages of centrifugal compressors into entirely new fields of application.

**ELLIOTT**  
Company





## PUTTING INDUSTRY'S MAGIC WHEEL TO WORK

### EXAMPLE: a process gas compressor

This is a single-stage H-line compressor, with open radial impeller. Casing diameter, 34 inches; total weight, 1020 pounds, capacity 3000 icfm. A conventional centrifugal to do the same job would be a 3-stage unit weighing about 9000 pounds.

Because corrosive gases will be handled, outer casing and all internal parts are made of stainless steels. This is economically feasible with Elliott H-line compressors due to their extremely small size and resulting light weight.

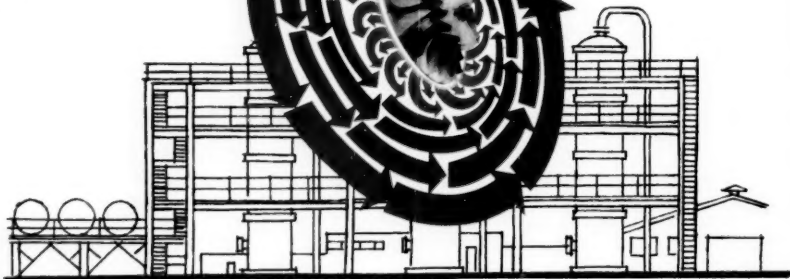
The one-piece, radial-bladed impeller has no cover or shroud member to create bending and hoop stresses.

Elliott H-line compressors include a wide variety of sizes and capacities, from 300 to 40,000 icfm.

The dependability of these compressors

is proved by many years of operating experience with thousands of Elliott machines of similar design.

For specific information, call your Elliott district office, or write Compressor Department, Elliott Company, Jeannette, Pennsylvania.



**ELLIOTT** THE MOST COMPLETE LINE OF  
**INTEGRATED COMPRESSOR  
& DRIVER UNITS** 500 cfm to  
600,000 cfm



## ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PA. PLANTS AT: Jeannette and Ridgway, Pa., Springfield, Ohio

**TURBINES • GENERATORS • MOTORS • COMPRESSORS •  
TURBOCHARGERS • EJECTORS • STRAINERS • TUBE CLEANERS**

# BRIEFS

some talk about sodium sulfide

- sodium sulfhydryte
- sodium chlorate
- thionyl chloride



## SODIUM SULFIDE... NO SETTLING REQUIRED

We put up sodium sulfide in small flakes so you get a faster dissolving action, even in cold water. You do away with settling and filtering, since the clear water solutions show no appreciable sediment.

The total sodium sulfide content is 60-62% with 35% water of crystallization. The chemical is relatively free from salt impurities. Iron content is 8 ppm maximum.

Check the coupon if you would like to learn more.

## 6 POUNDS OF SODIUM SULFHYDRATE DO 10 POUNDS OF WORK



These six pounds of sodium sulfhydryte give as much sulfidity as ten pounds of sodium sulfide, and about half the alkalinity.

A little quick arithmetic will show you that you'll need 40% less sodium

sulfhydryte to do the same job. So you will have to buy and store that much less chemical. Like our sulfide, the sulfhydryte is also completely and rapidly soluble in cold water and can usually be used without filtering or decanting.

This sodium sulfhydryte assays 70-72% with water of crystallization at 18 to 26%. Iron content is held to 5 ppm or lower.

You can find out more by returning the coupon.

## SODIUM CHLORATE... 99½% PURE



That's the purity of our sodium chlorate in the technical grade.

Hooker sodium chlorate is available in the form of white crystals. It's very soluble in water and is a very strong oxidizing agent.

Our sodium chlorate is used as a source of chlorine dioxide and as an oxidizing agent in dye manufacture and metallurgy.

You also have a choice of shipment:

steel drums of 100, 450, 600 pounds net or in tank cars of 80,000 or 100,000 pounds bulk, minimum weight.

Want more facts? The coupon will bring you data.

## HAVE A NEED FOR THIONYL CHLORIDE?



You can use our thionyl chloride in organic synthesis to replace with chlorine various groups such as OH, SH, SO<sub>2</sub>, H or O. It's especially useful in making organic acid chlorides and anhydrides.

Thionyl chloride reacts with hydroxyl groups in organic compounds to form gaseous by-products, SO<sub>2</sub> and HCl, which can be easily removed.

Thionyl chloride is available in two grades to give you the purity needed: 98% for the refined and 93% for the technical.

It can be used to introduce sulfur alone or a sulfur-oxygen combination... and as a chlorinating agent in the manufacture of isoamyl chloride, synthetic pyrethrum, phenyl propyl chloride and synthetic vitamin A palmitate.

As a start to using it yourself, send the coupon, and we'll send you our thionyl chloride data sheet and Bulletin 328-B, Hooker Chlorinating Agents, a 20-page brochure on reacting thionyl and other chlorinating agents.

For more information, check the chemical you're interested in and include your name, title and firm address.

- ☐ Sodium sulfide
- ☐ Sodium sulfhydryte
- ☐ Sodium chlorate
- ☐ Thionyl chloride, data sheet and Bulletin 328-B

### HOOKEER CHEMICAL CORPORATION

406 Forty-seventh Street, Niagara Falls, New York

Sales Offices: Buffalo Chicago Detroit Los Angeles New York  
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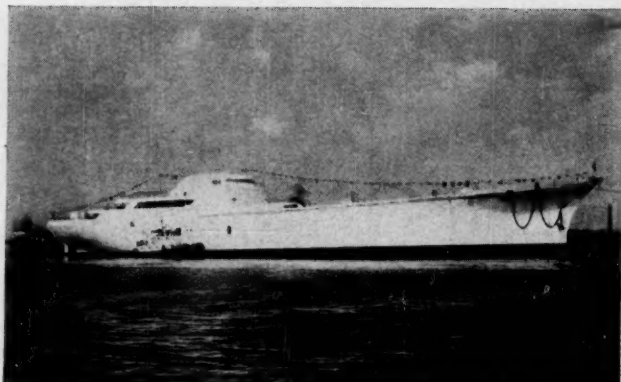
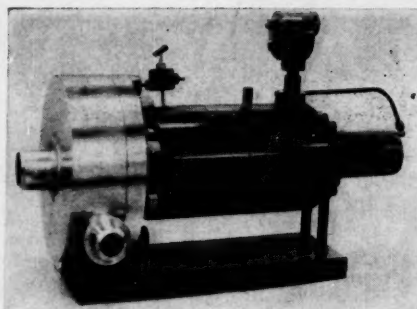
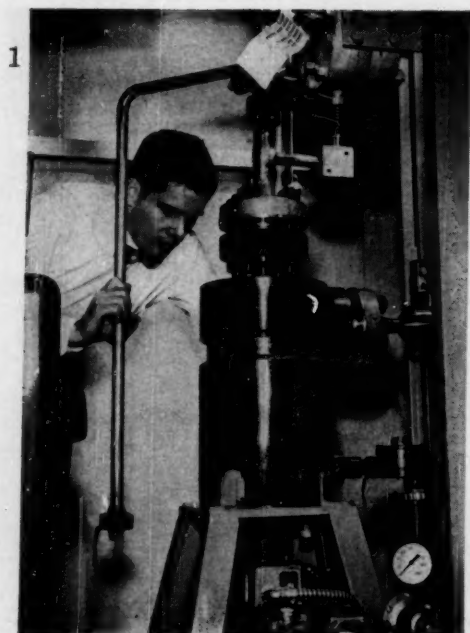
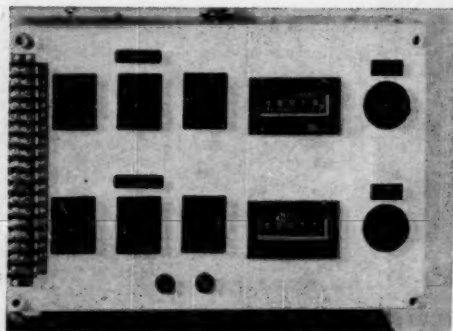


PHOTO COURTESY OF NEW YORK SHIPBUILDING CORPORATION

## A PUMP IN SEARCH OF A TOUGH JOB



**1** At General Electric Co.'s Hanford Atomic Products Operation, this CHEMPUMP performs at 30 gpm, 100' TDH, 700° F, and 3000 psi line pressure. Several others circulate water at 575° F and 1700 psi.

**2&3** N.S. SAVANNAH, world's first nuclear merchant ship, uses this CHEMPUMP to circulate primary coolant at 1750 psi, 520° F, 245 gpm and 110' TDH. Other CHEMPUMPS handle radioactive waste with suspended solids and non-condensable.

**4** CHEMPUMP developed this automatic controller (illustrated) and leakproof valve operator for use in a 1050° F and 1000 psi helium line. Designed in cooperation with the Darling Valve Company, it contains the helium with zero leakage and provides automatic valve positioning with an accuracy of 0.2%.

Nuclear applications call for pump specifications so tough few pumps can meet them. Not so CHEMPUMP®.

A part of every major nuclear installation in the last ten years, CHEMPUMP is handling tough radioactive fluids like isotope solutions, uranyl nitrate, fluorides, heavy water, bromine trifluoride . . . under performance specifications like these:

LEAKAGE . . . . .	zero (. . . in or out)
SHAFT SEALS . . . . .	none
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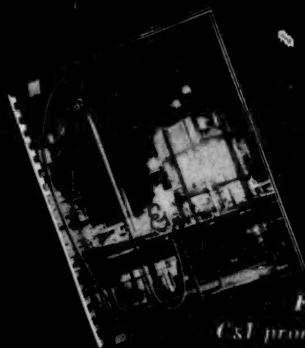
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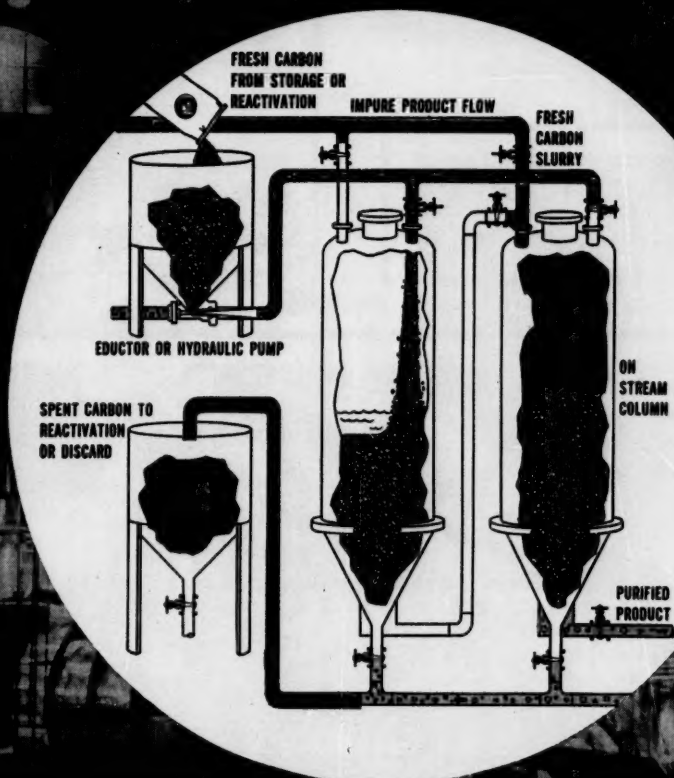


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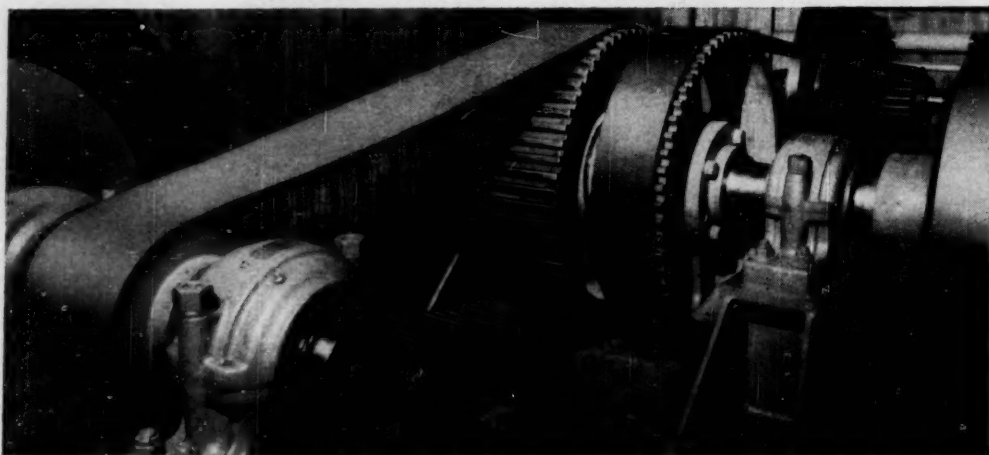
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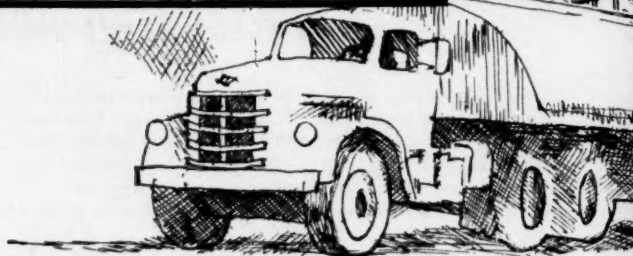


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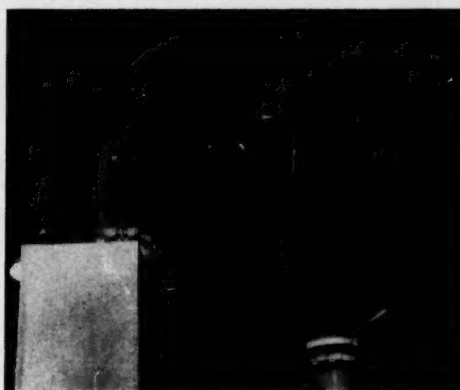


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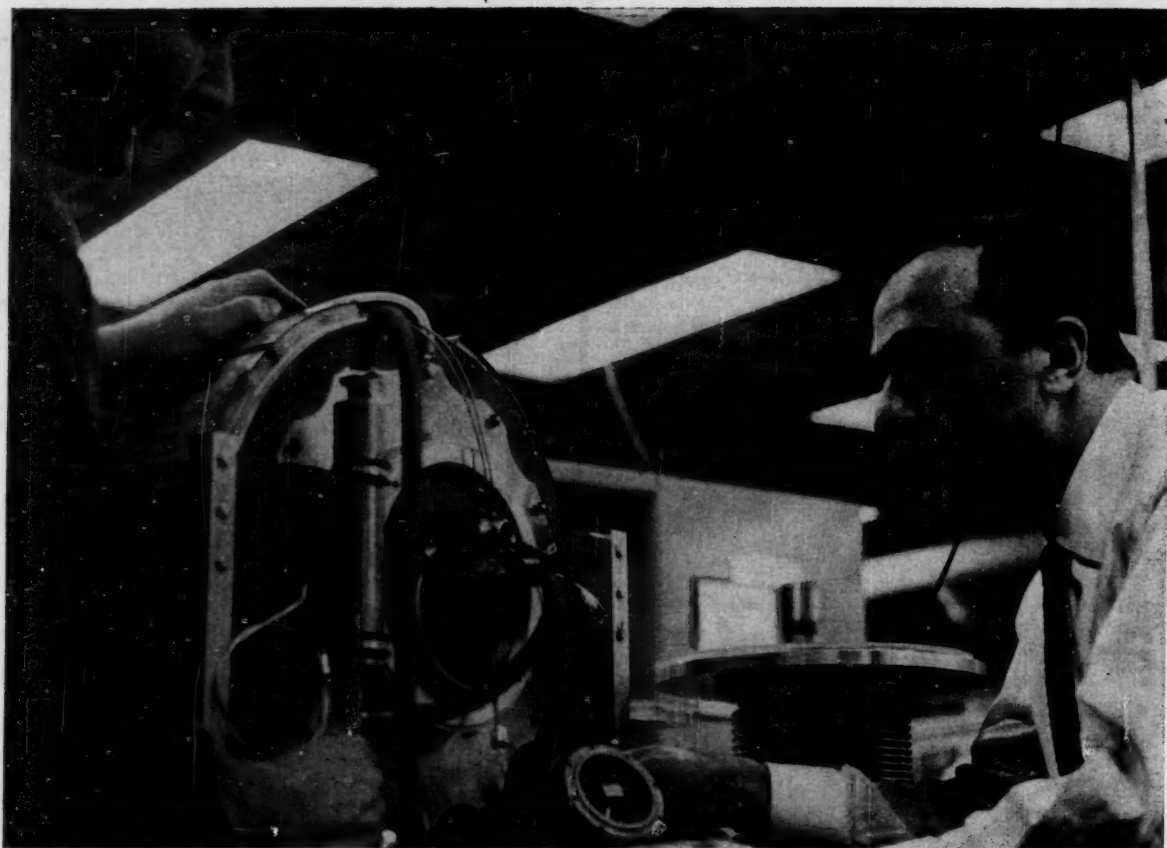
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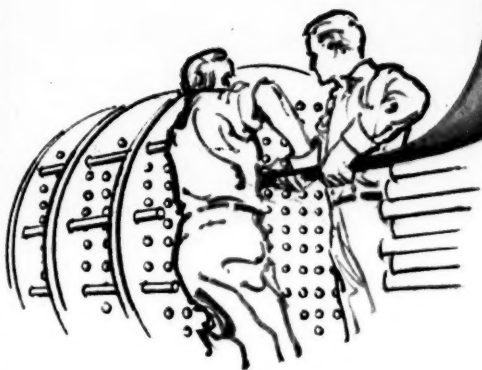
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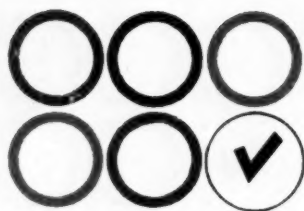
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PLEASE ANSWER ALL QUESTIONS AS COMPLETELY AS POSSIBLE



TEAR OUT HERE

- 1 What is O.D. of material? Wall Size? Quantity? Alloy?
- 2 Describe corrosive product with percent of concentration.
- 3 What is maximum temperature of corrosive product?
- 4 What is tube side operating pressure?
- 5 Is environment oxidizing or reducing?
- 6 What is present tube life?

## FILL IN AND MAIL



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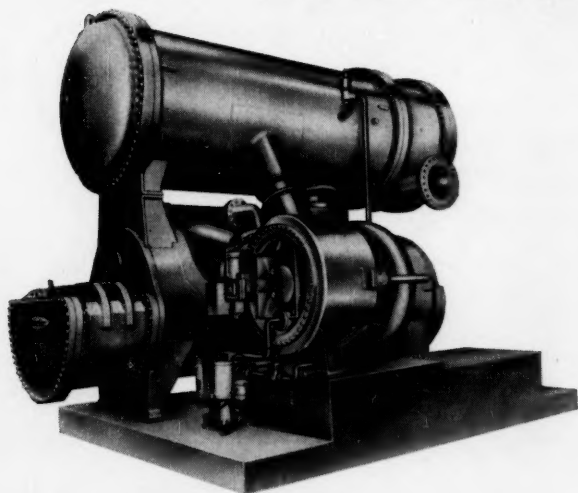
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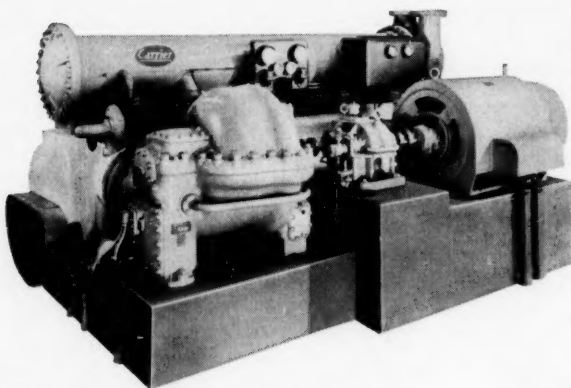
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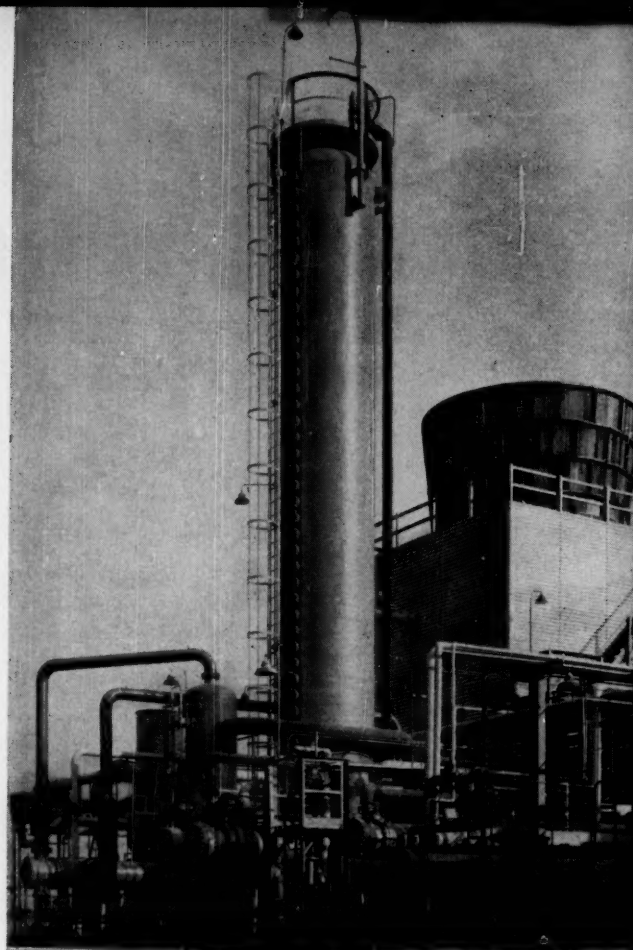
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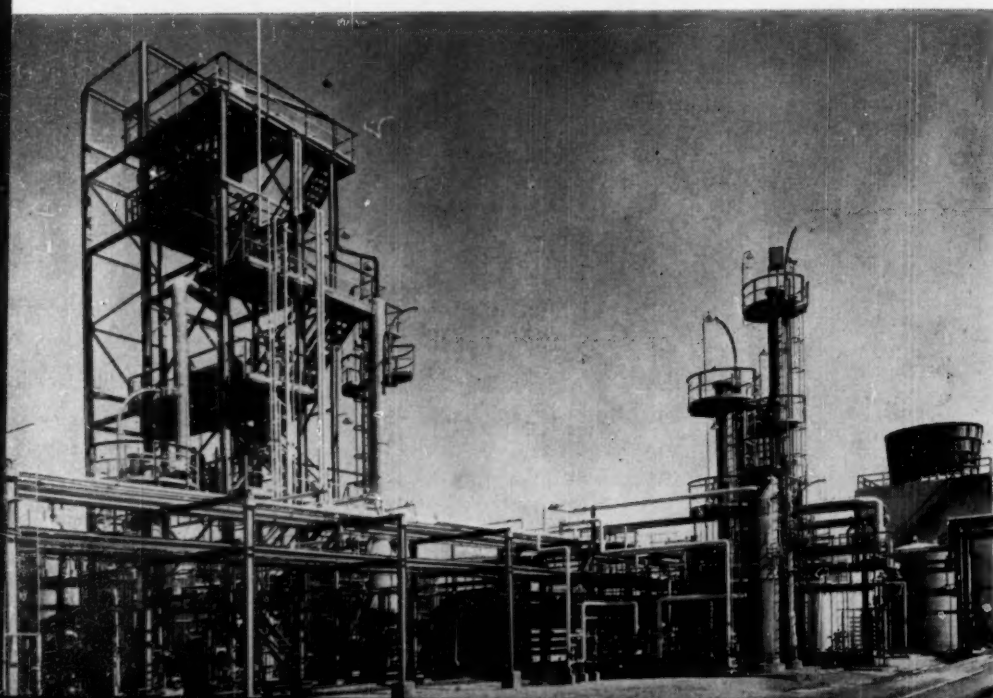
**Carrier** Air Conditioning Company

## **Pulp Plant Wrings Profit From Lignin**

*Crown Zellerbach Corp. has added a fresh twist to processing of lignin-bearing black liquor from its Bogalusa, La., pulp mill. A new, adjacent plant converts much of the lignin's methyl content to marketable dimethyl sulfide and sulfoxide.*



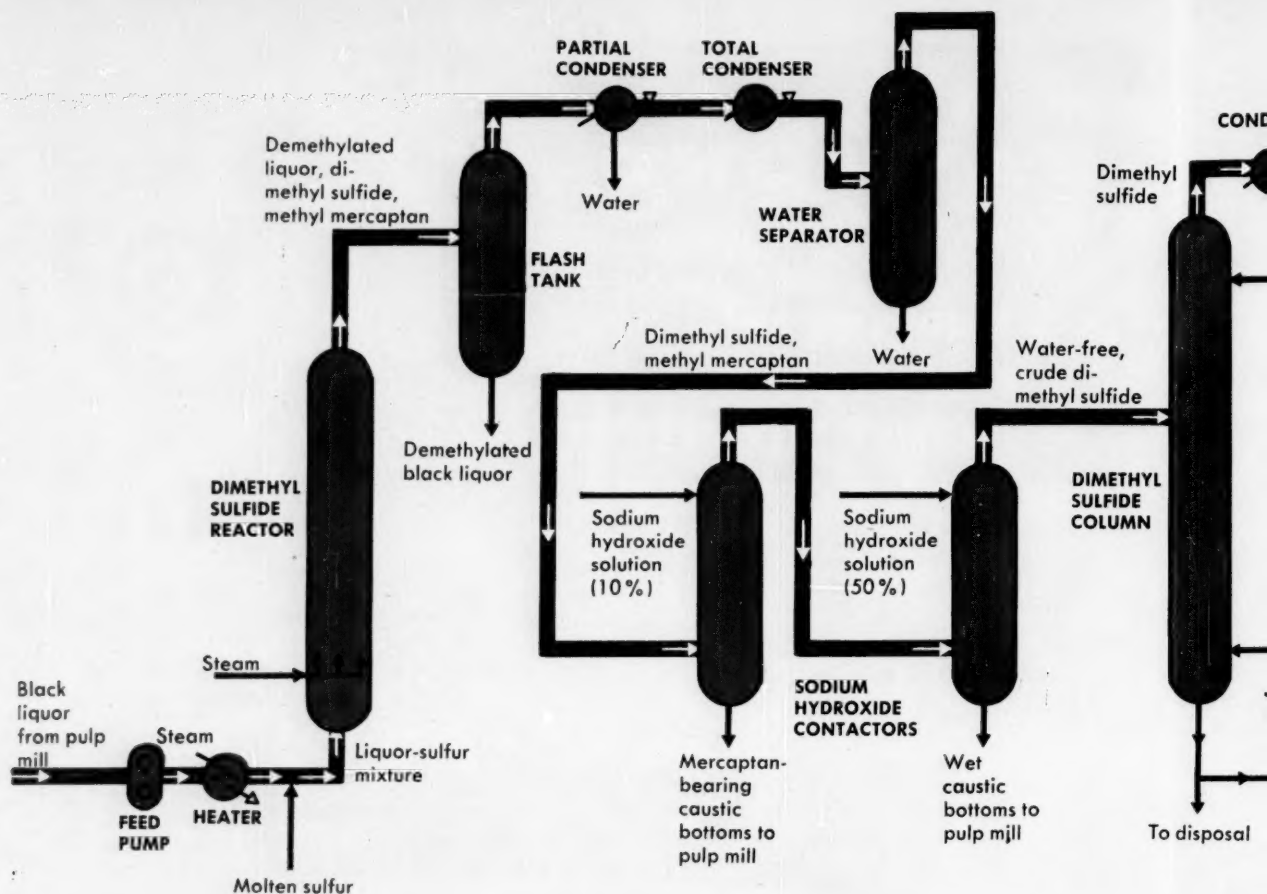
M. D. ROBBINS  
West Coast Editor



New plant, left, not only wins dimethyl sulfide and sulfoxide, but its operations also amount to an upgrading of black liquor, which returns to the pulp mill. Vertical reactor, above, converts methyl constituents of lignin to dimethyl sulfide and methyl mercaptan.







A 5-million-lb./yr. dimethyl sulfoxide plant, placed on stream by Crown Zellerbach Corp. at Bogalusa, La., late last year, represents what the paper firm considers a major breakthrough in its long-standing efforts to win profitable commercial chemicals from lignin, the noncellulosic constituent of wood.

With its new facility, the company is the sole U.S. producer of dimethyl sulfoxide. A former supplier, Stepan Chemical Co., has not re-entered the field since an explosion deactivated its sulfoxide plant in 1959.

Crown Zellerbach is aiming its new Bogalusa output at a promising, growing market that is based largely on two outstanding characteristics of dimethyl sulfoxide: it is a first-rate solvent, and a good medium for chemical reactions—some reactions have been measured up to 100,000 times faster in the sulfoxide than in other media. Principal current outlet, resulting from pioneer work in Japan, is as a solvent for spinning polyacrylonitrile fibers.

Raw material for the Bogalusa unit is black liquor—lignin-bearing spent liquor from digestion in the kraft pulp process—supplied by the firm's

nearby pulp mill. It is first reacted with sulfur to form dimethyl sulfide. Latter has a significant market of its own, mainly as an odorant for natural and artificial gases. Part of it is withdrawn from the process for direct sale; the rest is oxidized to yield sulfoxide product.

Over-all plant was engineered by Fluor Corp., Los Angeles. Dimethyl sulfide portion of the unit is rated at 10 million lb./yr.; the sulfoxide portion, currently half this size, is readily expandable as the product market develops. Stainless steel is the predominant material of construction throughout.

► **First, Dimethyl Sulfide**—In line with standard kraft pulp technology, Crown Zellerbach concentrates its black liquor in vertical evaporators at the pulp mill, to about 45% solids. Then the concentrated feed stream for the sulfide-sulfoxide unit—172 gpm.—is fed to a heater through a specially designed positive-displacement pump that discharges the liquid at 200 F., 500 psi. Combination of pressure and capacity requirements necessitated a special design of stainless steel.

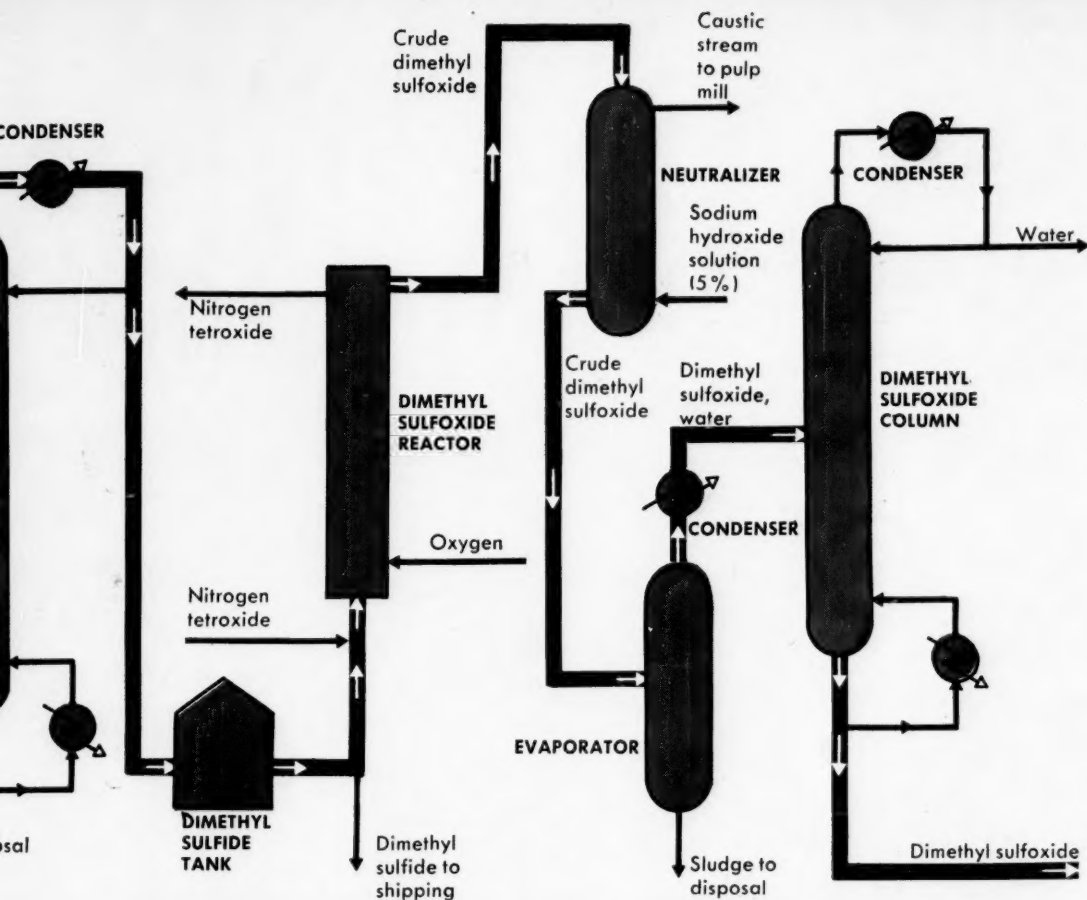
Liquor is heated by steam in a tubular heat

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hanger, then line-blended with molten sulfur. The mixture goes to a reactor column where superheated steam raises the temperature to 450 F. In this vessel, the methyl groups in the lignin are converted to dimethyl sulfide, methyl mercaptan. The reactor effluent leaves overhead, goes to a knock-out tank. Demethylated black liquor bottoms from the latter vessel to the pulp mill. Meanwhile, the sulfide and mercaptan—representing 2 1/2% of the black liquor fed to the plant—enter the flash stream. They pass through a separator and total condensers to a knockout drum which separates water from the mixture.

Next step is to remove the mercaptan and sulfur by successive washings with 10% and 50% sodium hydroxide solutions, in column configurations that are segmented with baffles. Effluent from these streams are routed to the pulp mill. After these details are worked out, company plans to recover the mercaptan, anticipates 500,000 lb./yr. Final dimethyl sulfide purification is accomplished in a distillation column. Finished sulfide goes overhead, is condensed and goes to a storage tank. High-boiling bottoms are discarded.

► **Then, Dimethyl Sulfoxide**—To make dimethyl sulfoxide, the sulfide is line-blended with nitrogen tetroxide and the mixture enters the bottom of a reactor. Function of the nitrogen compound is to oxidize the sulfide to sulfoxide.

Oxygen, which serves to reoxidize the tetroxide, also enters the bottom. Reacting mixture passes upward through the vessel. Product sulfoxide stream leaves the top as a liquid, then enters the top of a neutralizer where it descends countercurrently to a 5% sodium hydroxide solution. Spent caustic goes to the pulp mill, while the sulfoxide effluent is next fed to a short packed-column evaporator.

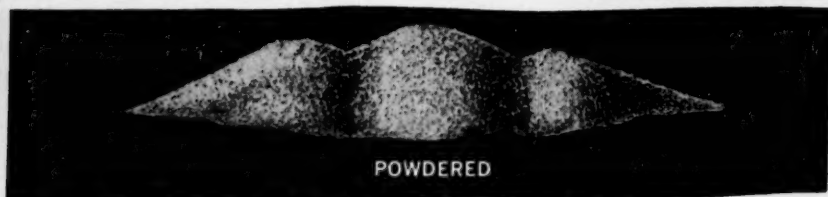
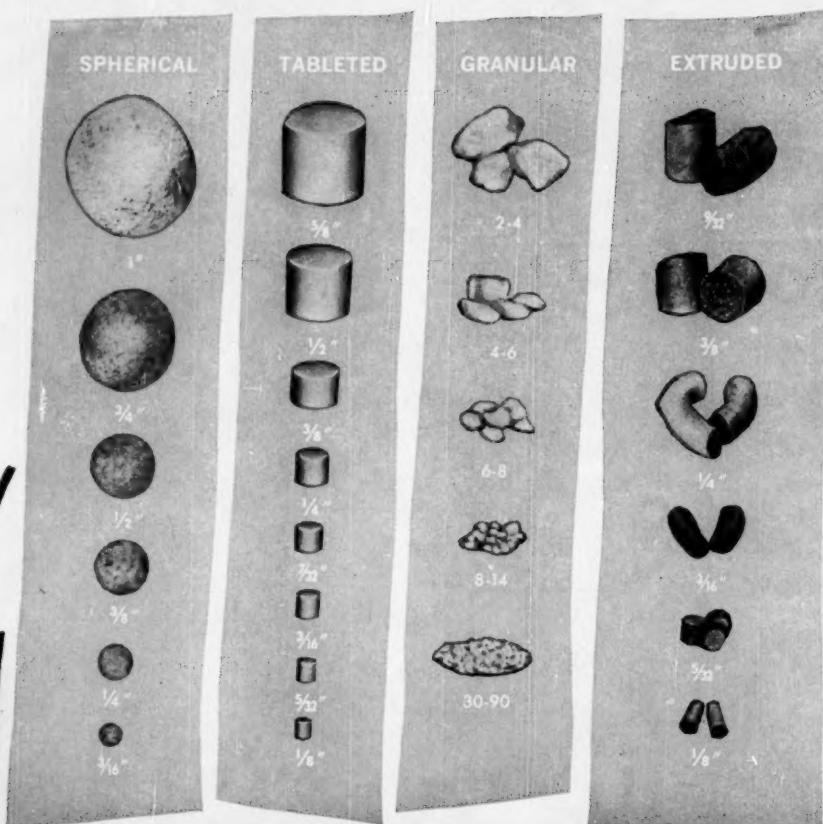
Reversing the conventional function of evaporators, this vessel yields the process stream as overhead vapor; residual concentrated liquor is discarded.

The vapor is a mixture of dimethyl sulfoxide and water. This stream is totally condensed and goes from a still feed tank to a distillation column. Finished sulfoxide is withdrawn as bottoms, ready for shipping in tank cars, drums or smaller containers. Final purity is 99.9% with 0.1% water.

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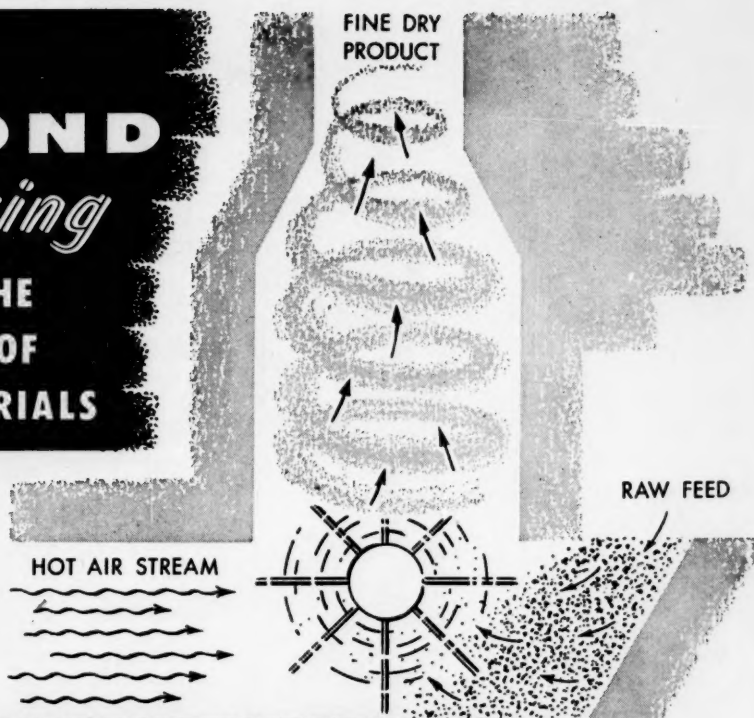
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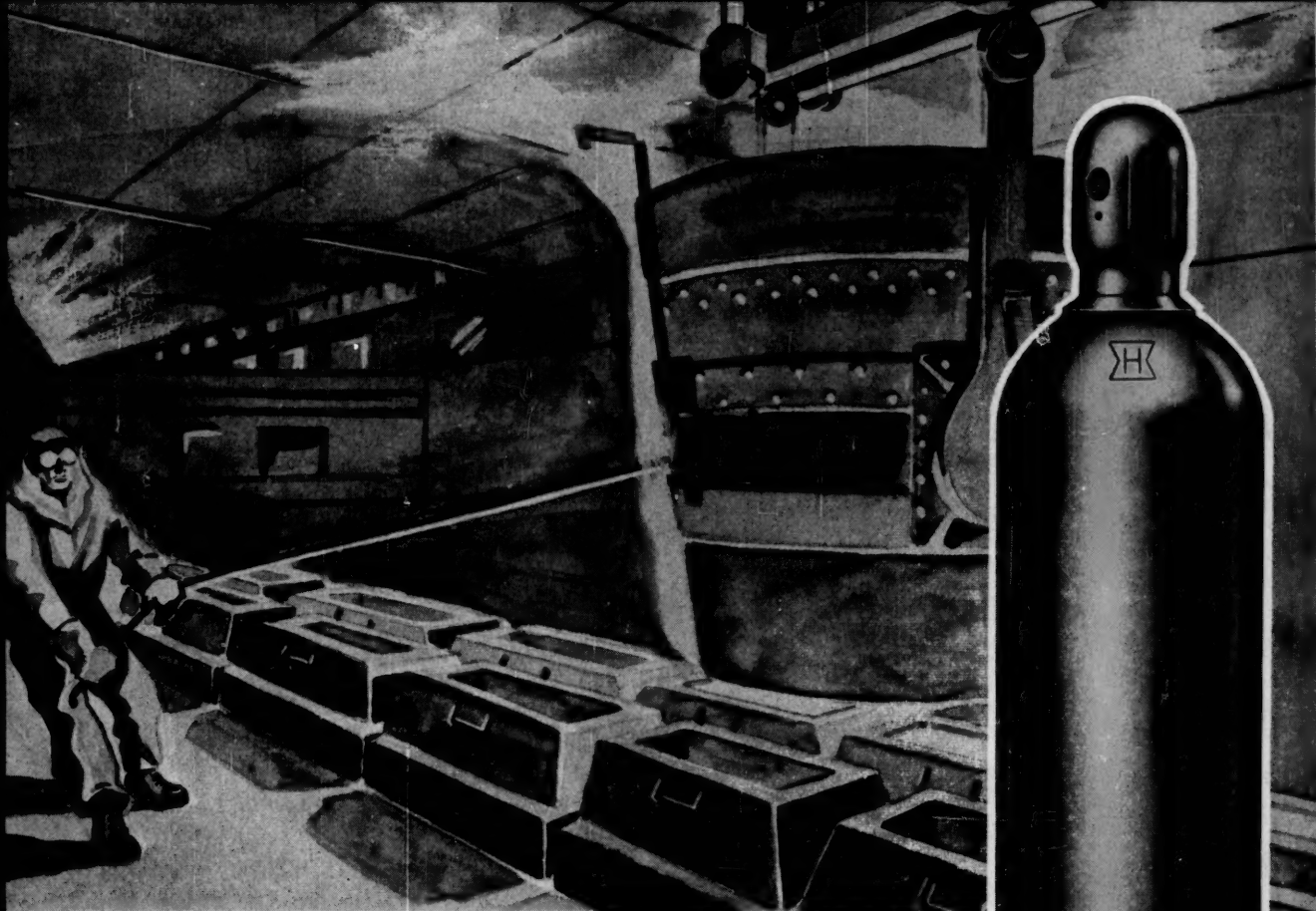
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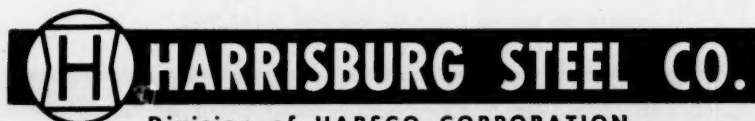


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Although fabric filters for dust collection have been under development for many years, the selection of the best for any given job is still a perplexing and often costly task for the many industries that use them. However, several years of study at Mellon Institute, in a research project of Albany Felt Co., have established the parameters that affect this selection and point up the fact that the electrostatic properties of both the dust and the collecting fabric are extremely critical in dictating filtration performance.

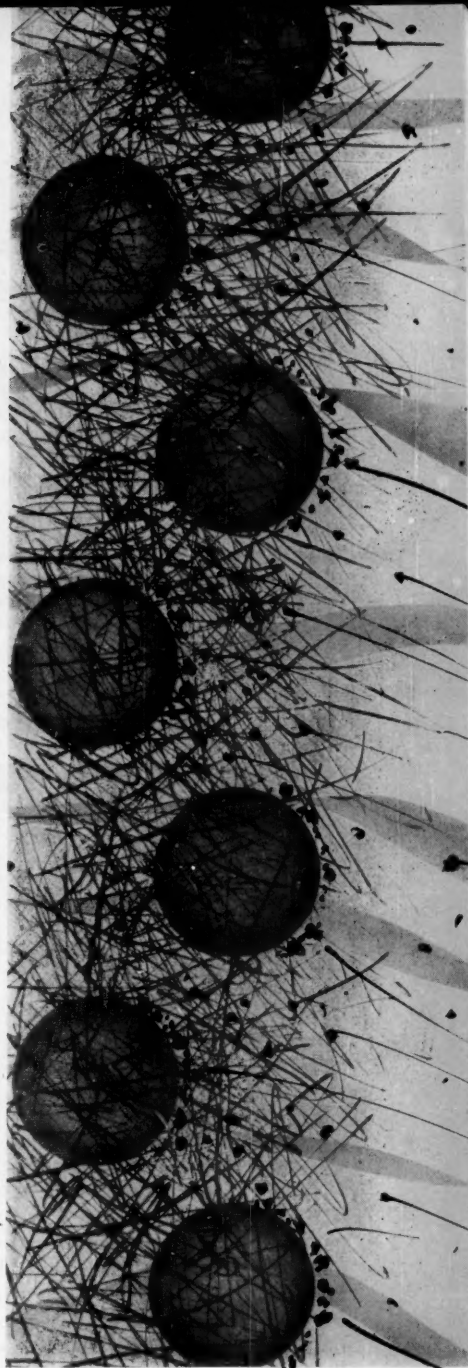
There has been basic progress in both fabric weaves and materials, yet very serious problems of selection still occur, even with what appear to be the most suitable fabrics and ideal operating conditions. The investigation considered these problems from the standpoint of the underlying theories. It found that electrostatics exercises a controlling influence in most dust collection operations, regardless of the method of collection used.

Thus, the study has added to classical filtration theory and offers a guide to selecting the filter medium with electrostatic polarity and discharge rate that will give optimum capacity and efficiency.

In classical dry filtration theory, it has been considered that particles are removed from the air stream on the fabric by four mechanisms of direct interception, gravitational settling, inertial impact and diffusion (Brownian movement), as diagrammed in Figs. 1 to 4.

It has also been recognized that the electrostatic attraction between oppositely charged bodies will withdraw particles from the air stream to the oppositely charged fibers, as shown in Fig. 5. Even if only one of the materials—particles or fibers—is charged, it may still induce a charge on the neutral material to produce a polarization force that promotes attraction and causes particle movement from the air stream to the oppositely charged fiber.

Our proposed addition to the filtration theory considers that electrostatic charges, in addition to their attractive influence between dusts and fabrics, are involved directly in particle agglomeration, fabric cleanability



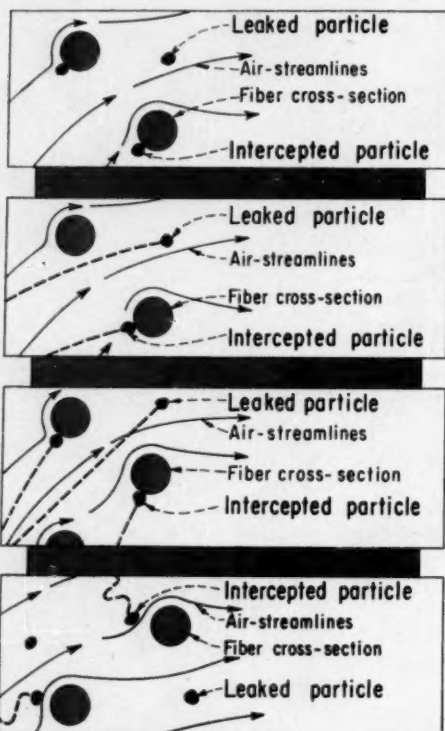
## How Dust Filter Selection Depends on Electrostatics

*Electrostatic behavior of both dust and filter fabric, and their rate of charge dissipation, exert a profound effect on filter operation.*

E. R. FREDERICK, Senior Fellow, Mellon Institute



## Classical Dry Filtration Theory Assumes Four Mechanisms



**Direct interception**—Air flowing around a fiber of the filter fabric is generally laminar, following a streamline course. Particles in the air stream tend to follow the same course but may be intercepted and removed by the fiber if the streamline passes at less distance than the particle radius. Removal here depends on the particle's position in the air stream and its size in relation to the fabric openings—Fig. 1.

**Gravitational forces**—Heavier particles in the air stream may settle out on the fibers because of gravitational forces in accordance with Stokes' law. Such removal is a function of a particle's settling velocity in relation to the filter area as projected on the horizontal plane. Thus, the effectiveness of gravitational removal depends on the ratio of particle mass to the horizontal component of the filter area—Fig. 2.

**Inertial impact**—A particle of suitable mass and inertia may follow the air stream until bending of the stream occurs. At this point, the particle's high inertia carries it out of the air stream in the original direction of motion. Both higher particle mass and higher air flow velocity favor this condition. Densification of the particles, as by agglomeration, can be an important factor in improving filter operation—Fig. 3.

**Diffusion of particles**—Brownian movement, the erratic motion of particles brought about by molecular bombardment of very fine particles, removes some of the material by interception on the fibers of the filter medium. Such movement is characteristic of small particles carried at low velocity. Diffusional contact, therefore, is favored when small particles move at low velocity against a large filter surface—Fig. 4.

and collection efficiency. Charge generation in fabrics and dusts is caused by frictional effects during filter operation. We shall review such concepts here in considerable detail.

### How Materials Are Charged

Whenever two dissimilar materials (usually, at least one is an insulator) are rubbed together, one becomes electropositive, the other electronegative. Helmholtz gave a simplified picture of electrification by assuming that, when two bodies are placed in contact, a transfer of charge occurs from one to the other to form an "electrical double layer" consisting of two layers of charge with opposite signs, one on or near each surface and of the order of a few molecular diameters apart.

Then, when the bodies are separated, if each surface retains a charge, very large differences in potential can result even though the original potential difference between the two layers was quite small. This concept may be represented—oversimplified, to be sure—by considering the charging to occur as illustrated in Fig. 6 by the rubbing together of two fabrics, Orlon and nylon. When either is rubbed by the other, the nylon will become positive (+) and the Orlon negative (−) in charge polarity. In like manner, other fibers may be included as the rubbed or rub-

bing material until each is located in the triboelectric ("friction electricity") series shown in Table I.

### The Triboelectric Series

All fabrics may be positioned in this series. While the same fabric will always fall in the same position, variations in preparing fibers of the same type, or changes resulting from process modifications, may alter the fabric's location in the triboelectric series. Every production fabric, regardless of its apparent similarity to another material already located in the series, must itself be evaluated to find its own series position.

The method of determining the triboelectric position and the charge dissipation rate of dust collection fabrics is quite simple. A 2-in.-wide strip of the test fabric is positioned in an insulated ring and is rubbed by a 1-in.-wide strip of a reference fabric mounted on a rotating insulated disk. The reference fabric is rotated through a fixed number of revolutions. The electrostatic voltage on the test strip is measured immediately after the controlled rubbing operation and again after the rubbed sample has been allowed to discharge for some fixed time. This time is usually 2 min.

The reference fabric may be changed to include as many materials as are used in actual practice or

as many as are to be included in the experimental filtration operations. The resulting data serve to position the trial fabrics in a triboelectric series and also to provide information on the rate of charge dissipation for each.

### Electrostatic Balance of Medium and Dust

In making use of electrostatics to improve dust filtration, we are concerned with three aspects:

- Polarity. Just as the fibers and fabrics may be listed in a triboelectric series (Table I), so the dusts can be classified in a similar series, as well as in the same series.

- Charge intensity. The intensity of charge developing on either fabric or dust, or both, may depend upon the processing conditions, as well as on the nature of the materials themselves.

- Charge dissipation rate. The ease of charge removal, or the rate of charge loss, is an especially important property of both filter medium and collected dust. The rate of charge loss by a fabric has a very marked influence on its ability to release the attracted dust.

In trying to determine dust classification and filter media requirements, attempts have been made to locate dusts in the triboelectric series, but these have had only limited success. The direct methods used in this laboratory to position the dusts are perhaps too crude. Hence, they have failed to provide as reliable a guide to the electrostatic properties of dusts as can be obtained from the experimental filtration trials that we conduct.

Accordingly, we have had to rely on these experimental data, together with such obvious dust characteristics as relative particle size and agglomerating tendencies, in preparing a guide to fabric selection for improved filtration performance.

The size distribution of a dust, while helpful, is not a necessary criterion in the characterization. It is more important to know whether a dust will agglomerate. If a dust of minutely dispersed particles will agglomerate, such a transformation can usually be achieved with a filter fabric of suitable electrostatic properties. Once agglomeration has been accomplished, the dust will be found to be less troublesome from the standpoint of leakage.

Other factors in the filtration process, however, may be improved through proper electrostatic and constructional balancing of the medium. Even though an extremely fine dust may pose a leakage problem because it does not tend to agglomerate, its filtration efficiency can be improved by a favorable dust-fabric electrostatic balance. This involves consideration of charge polarity and dissipation rate. Such fabric-dust balancing procedures, as well as those specified for relatively coarse dusts, are summarized in Table II.

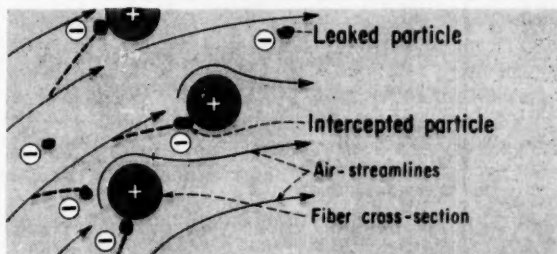
Table II shows three main dust classifications, which separate the two electrostatically active Classes I and II from the inactive Class III. Of at least 40 quite different commercial dusts that we have examined,

only two have demonstrated little or no electrostatic activity. Nevertheless, because there are many difficult-to-filter dusts that would not normally be submitted for our study, the "Inactive" (III) classification has been retained.

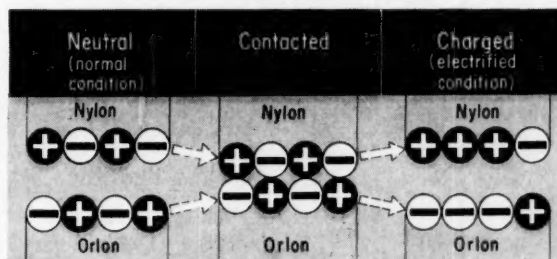
Classes I and II separate the nonagglomerating from the agglomerating types of electrostatically active dusts. The nonagglomerating dusts included in Class I are those dusts that display little or no agglomerating tendency under conditions of filtration, even when electrostatically active filter media are used. The agglomerating dusts (Class II) are those dusts that respond to charge neutralization and aggregation in contact with active filter media.

The agglomeration of dusts by the electrostatic process is disclosed in U. S. patent 2,896,263 assigned to the Albany Felt Co. These same general principles apply to the agglomeration of dusts by filter media.

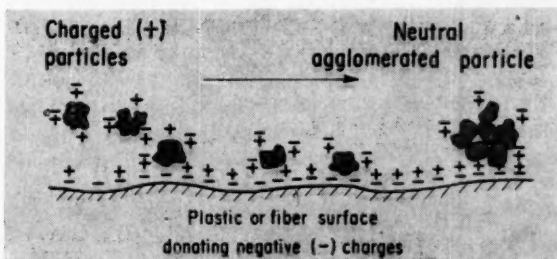
### How Electrostatics Affects Particle Interception



When filter fabric is charged oppositely to the dust, particles are attracted out of the air stream—Fig. 5



Oversimplified, this diagram shows how rubbing different fabrics together develops opposite charges—Fig. 6



Particles with similar charges repel; contact with charged fabric cancels charges, allows agglomeration—Fig. 7

This operation is represented in Fig. 7 and may be explained as follows:

In an electrostatically charged dust, the individual particles, predominantly of the same polarity, tend to repel one another. If the charge is removed, the particles may then come together freely and actually pack, especially if they are agitated. They then form large and often dense aggregates of the original sepa-

rated particles. This process of charge neutralization occurs between charged dusts and oppositely charged plastics or fabrics. A positively charged dust, for example, might be agglomerated by contacting a negatively charged plastic or fabric-like polyethylene. This same dust, however, may also be agglomerated by making contact with other suitably electronegative materials, or even with a fabric-like wool that is much more electropositive than the charged dust.

Because the deposition of relatively large particles (which are essentially electrostatically neutral) produces a noncompacted cake, the filtration of agglomerated dusts results in improved collectability without the development of excessive cake resistance. Often, the agglomerates are denser than the same powder in the nonagglomerated state. This, too, enhances cleanability.

If, however, the fabric charge persists at an appreciable level after the filtration cycle is ended, while the caked dust remains electrostatically active, cleanability may be impaired. In general, then, a high rate of charge decay is desirable for ease in cake removal.

The assignment of a dust to Class I or II may be made by visual observation. A clue to the agglomerating tendencies may be obtained by means of a simple test procedure. This is carried out by introducing about 100 milliliters of the dust—in the form in which this material would normally come to the dust collector—into a 1-qt. polyethylene bottle. (Actually, a glass or any other highly electropositive or highly electronegative container may be used instead.)

You then rotate the container for several minutes. Agglomeration will proceed and become evident if the fine particle size dust is susceptible to such a form change. While this simple technique may demonstrate that a dust will agglomerate in contact with a suitable filter medium, a negative test does not prove that agglomeration will not occur during the filtration. On the basis of our present experience, proof of agglomeration or nonagglomeration can be achieved only by an experimental or field filtration trial.

In Table II, the two primary dust classifications are subdivided into subgroups, A for fine and B for coarse particles. This is a relatively crude method of characterizing a dust. Obviously, actual particle size distribution data would be helpful. However, experience has indicated that a particle size analysis is not needed if the apparent fineness or coarseness of the dust, and its leakage properties, can be specified.

Locating a dust under one of the classifications of Table II is accomplished best on the basis of experimental filtration trials. These tests provide all the needed information on the dust's electrostatic activity, agglomerating tendencies, leakage and cleanability. Such data, together with the normal visual observations, will clearly classify the dust, especially when obtained from a study of several fabric filter media selected from different positions in the triboelectric series. When such information has been obtained, the preferred collecting fabric for the given operating conditions may be specified.

**Triboelectric Series for  
Production Fabrics—Table I**

Positive	
+25	
+20	Wool felt
+15	Glass, filament, heat cleaned and silicone treated Glass, spun, heat cleaned and silicone treated
+10	Wool, woven felt, T-2 Nylon 66, spun Nylon 66, spun, heat set Nylon 6, spun
+5	Cotton sateen Orlon 81, filament Orlon 42, needled fabrics Amel, filament Dacron, filament Dacron, filament, silicone treated
0	Dacron, filament, M-31 Dacron, combination filament and spun Creslan, spun; Azoton, spun Verel, regular, spun; Orlon 81, spun (55200) Dynel, spun
-5	Orlon 81, spun Orlon 42, spun
-10	Dacron, needled Dacron, spun; Orlon 81, spun (79475) Dacron, spun and heat set Polypropylene OI, filament
-15	Orlon 39B, spun Fibravyl, spun Darvan, needled Kodel
-20	Polyethylene B, filament and spun
Negative	



# Relations of Fabric Requirements to Dust Properties—Table II

Dust Classification	I-A	I-B	II-A	II-B	III
Relative particle size	Fine	Coarse	Fine	Coarse	Fine and coarse
Electrostatic properties	Active	Active	Active	Active	Inactive
Agglomerating tendencies	Little or none	Little or none	Positive	Positive	_____
<b>Criteria for Filtration</b>					
Leakage	$P_z$	Const. <sup>1</sup>	$P_z$ to $P_c$ <sup>2</sup>	$P_z$ to $P_c$ <sup>2</sup>	Fabric construction dictates performance
High flow, low delta P	Const. <sup>1</sup>	$P_m$	$P_z$	$P_z$	
<b>Criteria for Cleaning</b>					
Leakage control	$D_l$	Const. <sup>1</sup>	$P_z$ to $P_c$ <sup>2</sup>	$P_z$ to $P_c$ <sup>2</sup>	Fabric construction dictates performance
Ease of cake removal	$D_h$	$D_h$	$D_h$	$D_h$	

1. Fabric construction determines property. 2. Requires low density, rapidly agglomerating dust forming large aggregates. Nomenclature:  $P_z$  = Maximum potential difference between dust and fabric;  $P_c$  = Controlled potential difference between dust and fabric;  $P_m$  = Minimum potential difference between dust and fabric;  $D_h$  = High rate of charge dissipation;  $D_l$  = Low rate of charge dissipation.

## Technique of Filtration Trials

**Bench Unit, Shaker-Type Test**—The pilot model collector used here has a small bag, 3 in. in diameter and 25.2 in. long. Variations in filter media as well as different dusts are evaluated by cyclic filtration in which cleaning can be accomplished by depressurization, rapping or shaking. The flow rate and temperature of the gas, and the dust loading, are adjustable and controllable between practical limits. The dust is entrained in the heated air stream by an injector.

Such data as total, caked-and-plugged-cloth pressure drop, cake and plug solids weight, and such other pertinent information as fabric permeability and dust leakage, are readily obtained with the appropriate instruments. A normal evaluation proceeds through at least six cycles after equilibrium has been established, but the cyclic operation may be extended or interrupted for exposure of the plugged bag to a critical environment in order to obtain additional data.

**Day Unit, Reverse Air-Type Test**—A single bag of standard size (13 sq. ft. of cloth area) is used. Cleaning is by air reversal, provided with either a fixed or a spring-loaded cleaning ring traveling at constant speed, together with necessary air-flow and dust-loading controls. The cleaning air flow is adjustable between reasonable limits and the operating flow rate may be varied or held constant at any air-to-cloth ratio from 5 to 30 cfm./sq. ft.

From the record of pressure, we can determine the pressure characteristics of the clean cloth, the cake and the plug at a pre-established air flow rate, dust loading and reverse air flow rate. Equilibrium is usually reached within 4 hr. of continuous filtration and cleaning, and plugged cloth pressure drop and weight data are obtainable after about a 3-hr. period of constant reverse air cleaning without dust loading.

In order to obtain realistic performance data, it is usual to conduct several filtrations at flow rates ranging from 25 to 1 cfm./sq. ft. of cloth. The specific dust loading (i.e., the quantity of dust per cfm./sq. ft.) is maintained constant throughout the evaluation. The acceptability of a test fabric is determined by its

ability to perform at suitably low pressure drop and leakage under the accepted conditions of flow rate, dust loading and reverse air cleaning. Such other factors as fabric durability, ring-to-bag contact and dimensional stability are also considered in the final interpretation of the data.

Dust loading in each unit is regulated by means of screw feeders, vibrators and air-injecting dust-feeding systems. Air-heating elements and temperature-regulating controls are included in each unit to simulate service temperatures and humidity.

## Fabric Selection Based on Dust Properties

As we have seen, Table II represents an attempt to provide a general guide to fabric filter media specifications. The fabric requirements are given for obtaining optimum filtration performance in collecting the various types of dusts according to their grouping under five classifications.

**Class I-A Dusts**—Since baghouse operations are selected on the basis of the collection efficiency that they offer, leakage is accepted as an all-important criterion with Class I-A dusts. True, the leakage tolerance may vary somewhat depending upon the toxicity or value of the dust being collected, but a deviation from the ideal should be considered only if some other parameter is considered to be more critical.

The filter medium serves primarily as a support for the dust layer. This layer provides the only truly efficient filter surface. A new or a recently cleaned filter bag will leak more dust than a plugged bag. The protective cover of a dust film over the filter surface reduces leakage. This same condition must be achieved and maintained throughout every filtration cycle. This is particularly important during the period immediately following the cleaning operation.

Since Class I-A dusts are the fine particles that do not agglomerate, leakage can be controlled only by selecting a fabric with a marked difference in polarity from that of the dust. The greater the separation between the dust and the fabric in the triboelectric series, the greater the attraction between the materials.



Summary of Fabric Filtration Performance Data on Five Classes of Dusts—Table III

Fiber	Style	Permeability, Cu. Ft./ Sq. Ft. at 5 in. W.G.	Fabric Position in T.E. Series	Fabric Discharge Rate, % <sup>1</sup>	Relative Leakage	Resistance, In. W.G.	Filtration Properties			Remarks
							Flow Rate, Cfm./ Sq. Ft.	Relative Cleanability		
Class I-A (Calcined calcium silicate <sup>2</sup> ) (Classes defined in Table II)										
Orlon	W 40/804 <sup>4</sup>	24	+5	50	High	2.2	15	Good	Excessive leakage	
Orlon	40/804 <sup>4</sup>	26	+5	10	Low	2.4	15	Poor	Low leakage	
Dacron	40/423 <sup>4</sup>	29	No charge	100	High	1.6	15	Good	Excessive leakage	
Dacron	W 40/423 <sup>4</sup>	24	-10	10	Low	1.3	15	Poor	Low leakage and resistance	
Dacron	W 40/446 <sup>4</sup>	33	-10	15	Low	0.7	15	Poor		
Class I-B (Example 1, Flux-calcined diatomaceous earth <sup>3</sup> )										
Nylon	800 <sup>6</sup>	31	+15	100	Low	0.78	5	Very poor	Blinding tendencies	
Orlon 81	8218 <sup>6</sup>	183	-2	60	Low	0.31	5	Very good	High collectability and efficiency	
Orlon 81	8208 <sup>6</sup>	90	-2	80	Low	0.39	5	Very good		
Dacron	862 <sup>6</sup>	59	-10	40	Low	0.50	5	Fair	Average performance	
Class I-B (Example 2, Commercial finished cement <sup>7</sup> )										
Nylon	Type 6 <sup>6</sup>	96	+10	100	Low	4.8	6	Very poor	Low collectability; blinding tendencies	
Wool	880 <sup>6</sup>	107	+8	100	Low	4.8	6	Very poor		
Nylon	880 <sup>6</sup>	50	+12	100	Low	4.8	6	Poor		
Dacron	S-579 <sup>6</sup>	121	0	60	Low	4.8	6	Very good	High collectability and effy.; plug resistance	
Dacron	M <sup>2</sup> S-579 <sup>6</sup>	125	0	100	Low	4.8	6	Excellent		
Dynel	840 <sup>6</sup>	50	-10	50	Low	4.8	6	Fair	Moderate collectability; blinding tendencies	
Dacron	S-580 <sup>6</sup>	56	-10	65	Low	4.8	6	Poor		
Class I-B (Example 3, Ball clay <sup>5</sup> )										
Nylon	40/250 <sup>4</sup>	51	+10	30	Very high	Rising <sup>9</sup>	10	Poor	Excessive resistance and leakage	
Orlon	40/802 <sup>4</sup>	54	+5	30	Very low	0.66	25	Good		Low resistance and leakage
Dacron	40/800 <sup>4</sup>	92	-10	30	Very high	Rising <sup>9</sup>	20	Poor	Excessive resistance and leakage	
Dacron	E <sup>2</sup> 40/800 <sup>4</sup>	93	-10	100	High	Rising <sup>9</sup>	15	Fair		
Dacron	40/424 <sup>4</sup>	30	-10	30	High	Rising <sup>9</sup>	15	Poor		

## Notes:

1. Percent loss of charge in 2 min.
2. Test used experimental reverse air jet collection, 150 F., constant flow rate, constant reverse air cleaning at 3.7 in. w.g.; dust loading, 0.92-0.98 gram/(min.)(cfm.)(sq. ft.). An appreciable difference in the T.E. positions of the fabric and slightly negative dust, and low rate of charge decay from the fabric, restricts leakage.
3. Albany Felt Co. designations for treatments to alter fabric charge properties.
4. Albany Felt Co. designations for needed fabrics.

5. Test used experimental shaker-type collection, 180 F. with constant rate 10-min. filtration period and 2-min. reciprocating shaker-type cleaning; dust loading, 1.8-2.0 grams/(min.)(cfm.)(sq. ft.). In this case fabric construction not critical for leakage control. A minimum difference in location of fabric and dust in T.E. series favors formation of loose, low-resistance cake and restricts plug buildup.
6. Albany Felt Co. designations for spun staple yarn fabrics.
7. Experiment used experimental shaker-type collection, 180 F., constant rate filtration to pressure drop of 4.8 in. w.g.

8. Test used experimental reverse air jet collection, 150 F., constant rate filtration, constant reverse air cleaning at 3.7 in. w.g.; dust loading 5.5 grams/(min.)(cfm.)(sq. ft.). Leakage here is governed more by the relative position of the dust and the fabric in the T.E. series than by fabric construction (openness). The excessively electronegative fabrics, whether of 30

Selecting a fabric that is much more positive or much more negative than the dust (designated as *P*, in Table II), will therefore insure the development of the attractive forces needed to coat the fabric with the dust filter-aid. This is not the only requirement, however. If this charge differential is not retained long enough, overcleaning may occur and insufficient plug and/or cake remain on the fabric after the cleaning to afford protection against leakage. Accordingly, a low rate of charge decay (*D*<sub>1</sub>) is also a very critical requirement of the fabric used in collecting dusts that pose a leakage problem.

Since the electrostatic properties of the filter medium are fixed by the requirements for leakage con-

trol, the capacity and operating resistance of the system can be governed only by the construction (yarn, weave, etc.) of the fabric and by the processing conditions.

The cleanability requirements of the fabrics used for these dusts are fixed by the charge dissipation rate needed to insure high collection efficiency. As we have noted, only the construction of the fabric and the operating conditions can alter cleanability when the electrostatic requirements have been so specified.

Fortunately, very few dusts seem to fall into this very critical Class I-A type. Among those in this group, we found samples of a calcined calcium silicate and a zinc oxide sinter dust.

Fiber	Style	Permeability, Cu. Ft./ Sq. Ft. at 5 In. W.G.	Fabric Position in T.E. Series	Fabric Discharge Rate, % <sup>1</sup>	Relative Leakage	Resistance, In. W.G.	Filtration Properties		Remarks
							Flow Rate, Cfm./ Sq. Ft.	Relative Cleanability	
Class II-A (Example 1, Processed natural diatomaceous earth <sup>10</sup> )									
Nylon	800 <sup>8</sup>	19	+12	100	Moderate	>4	5	Very poor	Excessive resistance, blinding tendencies
Orlon 81	820B <sup>8</sup>	85	-2	20	Low	2.51	5	Good	Low resistance, leakage and plugging
Orlon 81	E 820B <sup>8</sup>	82	-2	100	Low	2.49	5	Excellent	
Class II-A (Example 2, Wheat starch <sup>11</sup> )									
Wool	Nonwoven	32	+20	0	Low	2.44	20	Very good	Low resistance, leakage and plugging
Nylon	40/251 <sup>4</sup>	36	+10	30	High	5.2	15	Poor	High resistance, leakage, plugging, low collectability
Dacron	EA <sup>3</sup> 340/434 <sup>4</sup>	73	-10	100	Very high	>9 (rising <sup>9</sup> )	15	Very poor	
Dacron	40/434 <sup>4</sup>	72	-10	30	High	>8 (rising <sup>9</sup> )	15	Very poor	
Darvan	40/600 <sup>4</sup>	28	-15	20	Low	2.45	20	Very good	Low resistance, leakage and plugging
Class II-A (Example 3, Taconite <sup>12</sup> )									
Dacron	134B <sup>4</sup>	75	-10	30	Low	1.61	28	Good	Low resistance, leakage and plugging
Dacron	A <sup>3</sup> 134B <sup>4</sup>	75	0	100	High	>2	15	Poor	High resistance, leakage and plugging
Class II-B (Carbon SRF <sup>13</sup> )									
Glass	P2478 <sup>8</sup>	76	+15	30	Very low	4.0	4	Fair	Fair collectability, blinding tendencies
Glass	AL <sup>2</sup> P2478 <sup>8</sup>	61	+15	100	Very low	4.0	4	Good	Good collectability
Class III (Kaolin <sup>14</sup> )									
Dacron	40/424 <sup>4</sup>	29	-10	30	Very high	Rising <sup>9</sup>	15	Poor	Excessive resistance and leakage
Dacron	40/428 <sup>4</sup>	21	-10	30	High	Rising <sup>9</sup>	20	Fair	
Dacron	40/420 <sup>4</sup>	41	-10	30	Moderate	Rising <sup>9</sup>	25	Fair	
Dacron	40/800 <sup>4</sup>	91	-10	30	Very low	0.90	25	Good	Low resistance, leakage and plugging;
Dacron	NXD-89 <sup>4</sup>	100	-10	30	Very low	0.55	25	Good	impracticable construction
Darvan	40/600 <sup>4</sup>	27	-17	20	Low	1.80	25	Fair	Borderline performance

or 93 permeability, failed because of high resistance which caused dust penetration.

9. An equilibrium value was not reached.

10. Test used experimental shaker-type collection, 180 F., with constant rate 10-min. filtration period and 2-min. reciprocating shaker-type cleaning; dust loading, 0.9-1.1 grams/(min.)(cfm.)(sq. ft.).

11. Test used reverse air jet collection, 150 F., with constant rate filtration, constant reverse air cleaning at 3.7 in. w.g.; dust loading, 3.9-4.2 grams/(min.)(cfm.)(sq. ft.). A large polarity difference between dust and collecting fabric pro-

motes agglomeration to minimize dust compaction and protect the medium against dust penetration and plugging.

12. Test used reverse air jet collection, 150 F., with constant rate filtration, constant reverse air cleaning at 3.7 in. w.g.; dust loading, 3.9-4.2 grams/(min.)(cfm.)(sq. ft.). At almost twice the air flow and dust loading, the more negative fabric performed at sufficiently reduced resistance (<2 in. w.g.) to retain this agglomerating type dust.

13. Test used shaker-type collection, 180 F., with constant rate filtration to 4 in. w.g. pressure drop, repressurizing and reciprocating shaker-type cleaning; dust loading, 2.1-2.6

grams/(min.)(cfm.)(sq. ft.). The normally highly electro-positive glass fabrics promote agglomeration of this dust to provide favorable filtration properties. An increase in the rate of charge decay further enhances collectability and reduced plugging.

14. Test used reverse air jet collection, 150 F., with constant rate filtration, constant reverse air cleaning at 3.7 in. w.g.; dust loading, 1.9-2.4 grams/(min.)(cfm.)(sq. ft.). Fabric construction variations (weight, thickness, base and web properties) account for differences. Permeability not the only criterion determining leakage.

**Class I-B Dusts**—These dusts are nonagglomerating and electrostatically active, and not so fine as to pose a serious leakage problem.

Their retention is satisfactorily achieved through the variations permitted in fabric construction. Electrostatic balancing between the fabric filter medium and the collected dust may then be applied to attain optimum levels in other filtration parameters.

A loosely packed cake will insure low resistance to air passage and, consequently, will provide high capacity. This feature of the formed cake can be realized by selecting a filter medium with a minimum difference in charge polarity ( $P_m$ ) when compared with the polarity of the dust being collected. With such a

fabric, fiber-to-dust attraction is minimized and the resulting cake will not compact tightly but will be porous to air flow. Since exact equalization of the polarity of the electrostatic charges in the fabric and dust is impossible, a high rate of charge dissipation ( $D_c$ ) will also be desirable for producing a low-density cake.

A high degree of cake removal, with restricted plugging and minimized blinding tendencies, can often be realized in a fabric used in the collection of these coarse, nonleaking dusts. The same high rate of charge dissipation needed for high flow rate and low resistance will also insure minimum attraction and best removal of the dust during the cleaning period.

Some of the dusts that fall into the Class I-B type are: finished (common) cement, HAF carbon, converter-type zinc oxide, corn starch, ball clay, and a flux-calcined diatomaceous earth.

**Class II-A Dusts**—These are electrostatically active, fine-particle dusts that will agglomerate. They must be agglomerated to avoid leakage difficulties and to achieve the ultimate in the other filtration properties.

Agglomeration of the fine particles through the use of highly positive or highly negative fabrics according to the principles of our U.S. patent 2,896,263 (see Fig. 7) changes the particulate material from a condition that would normally tend to leak through the fabric, to one that can be retained by a suitably constructed fabric. Once the agglomeration has been satisfactorily achieved by a fabric of opposite polarity ( $P_2$ ), then fabric construction can be controlled to avoid leakage.

An agglomerated dust cake cannot become as tightly compacted as the same dust in the fine and dispersed particle state. The same agglomerating conditions required for leakage control, which are achieved by charge neutralization of the dust by suitably electro-positive or electronegative fabrics, are favorable for collecting a cake of low resistance and, therefore, for maintaining a high capacity in the filter system.

In addition to the advantage of a high rate of charge dissipation in the fabric medium, another property of the deposited cake may also improve cleanability. A high rate of charge loss from the collecting fabric will insure that little or no attraction exists between the dust and fabric during the cleaning operation. The increased cake weight that results from depositing a porous agglomerated cake instead of a compact, fine-particle cake, will also improve cleanability. Combining these preferred electrostatic and operational features has, in fact, permitted simplifying cleaning practices even to the extent that mechanical shakers have been eliminated in some baghouse operations.

Several dusts assigned to Class II-A actually possess properties that might suggest a resemblance to the Class I-A dusts. When agglomeration has been found to be inadequate to provide a satisfactory proportion of coarse aggregates (with the agglomerates too small for the fabric construction to retain them), a low rate of charge dissipation has been found necessary to restrict leakage.

Dusts in Class II-A seem to be more common than dusts assigned to other classifications. They are represented by a slag fuming type of zinc oxide, natural diatomaceous earth, raw cement, nickel-melting furnace dust, magnesite, Philippine chrome, cellulose acetate, taconite, wheat starch, powdered sugar and molybdenic oxide.

**Class II-B Dusts**—These are electrostatically active, coarse in particle size, and capable of agglomerating. They usually present no leakage problem that fabric construction cannot control. Optimum fabric performance in terms of filtration rate and cleanability may also be achieved by taking advantage of the polarity and charge dissipation properties needed to insure agglomeration and dust release. Depending upon the

operation, a high rate of charge decay ( $D_2$ ) may be a more critical requirement than the appreciable difference in charge polarity ( $P_2$ ) needed to accomplish agglomeration.

At least one of the carbon black dusts, SRF, and a silicon dioxide dust seem to fall into Class II-B.

**Class III Dusts**—Since Class III dusts are electrostatically inactive, neither the charge polarity nor the charge dissipation rate of the collecting medium should influence filtration performance. Only the fabric's constructional features dictate operational parameters and collection efficiency.

Of the commercial dusts we have examined experimentally, only two have shown a lack of significant electrostatic activity. Both kaolin clay and oat grindings appear to belong to this Class III category, since in reverse air filtration trials the fabric constructional features alone influenced filtration properties.

To sum it up, our findings show the electrostatic requirements of the fabric are dictated by the electrostatic activity and certain other physical properties of the collected dust. While the triboelectric polarity and charge dissipation properties of fabric filter media are rapidly estimated, these same properties are not so easily measured for the dusts. Accordingly, in classifying dusts, we have had to rely on the same experimental operations that implied the existence of an electrostatic balance relationship between filter media and dusts. Once this classification is established, fabric prescription becomes precise.

The writer gratefully acknowledges the constructive cooperation of Harold F. Hedberg, Carlton C. Gordon and Frederick E. Heinemann of the Albany Felt Co.; the contributions in equipment design by George A. Bartholomew; and the operation of the test units and accurate recording of data by Daniel T. Muth and William R. Brinkhoff.

Meet  
the  
Author



**EDWARD R. FREDERICK** is a Senior Fellow at Mellon Institute, in Pittsburgh, Pa. Since 1954, he has been engaged on an Albany Felt Co. project concerned with fiber and fabric problems associated with industrial fabrics.

He received his B.S. degree in chemistry from Carnegie Institute of Technology, and in chemical engineering from the University of Pittsburgh. Serving with Mellon Institute since 1939, Mr. Frederick holds over 20 U.S. patents.



# Kinetic Plots Aid Catalytic Operations

*New way of plotting performance data for catalytic reactors helps the plant design man to plan for improved operation, and the plant operating man to achieve it.*

DONALD B. BURKHARDT

President, Von Bree, Inc., Newark, Del.

To provide a convenient method of communicating between the theoretical kineticist and the practical operating man or reactor designer, we have developed a new method of plotting kinetic data involved in catalytic reactions. Although the method was intended initially for presenting information on  $\text{SO}_2$  oxidation in contact sulfuric acid plants, it can be used with little or no change in most catalytic reactions.

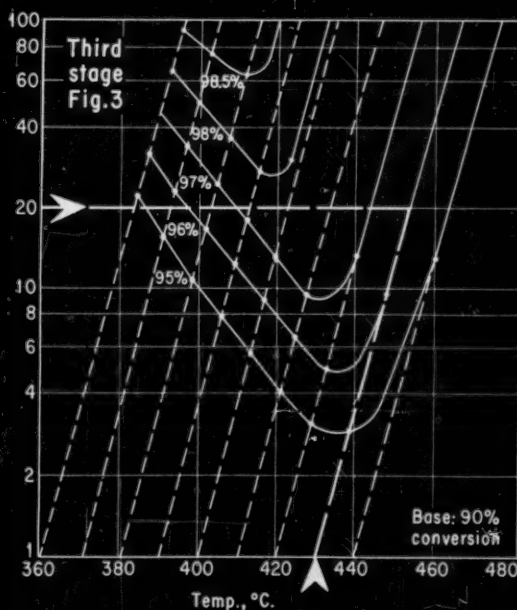
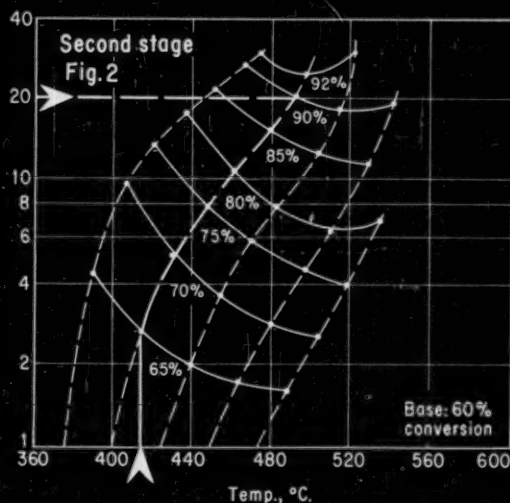
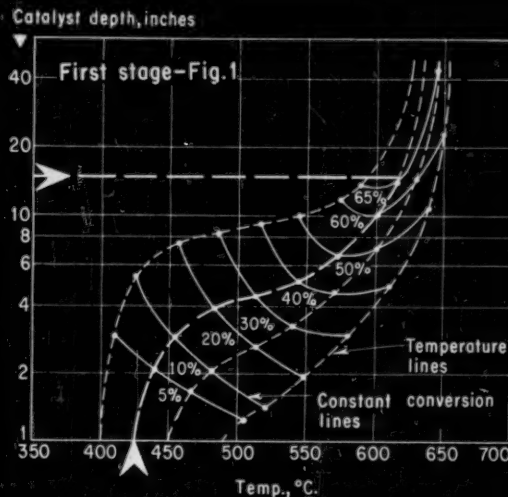
As used here, the method applies specifically to cases of gas-solid contact. With autocatalytic reactions, of course, some other parameter than catalyst bed depth would have to be used, e.g., reactor length.

Donovan<sup>1</sup> has recently discussed the desirability of having graphs showing the extent of conversion of  $\text{SO}_2$  to  $\text{SO}_3$  vs. catalyst bed depth for specific feed gas compositions, gas flow rates and catalyst characteristics. However, it is more useful in practice to prepare plots of gas temperature vs. catalyst bed depth, as shown in Figs. 1, 2, and 3. These charts are for three-stage, fixed-bed, adiabatic converters as commonly used in acid plants.

In constructing such charts, note that the curves labeled "temperature lines" show the temperature history of gas at a particular entering temperature and degree of conversion as it moves through the catalyst bed. In Fig. 1, for example, unconverted  $\text{SO}_2$  entering at 400 C. reaches 410 C. after 3 in. of bed travel—rising to 545 C. after 10 in. of travel. In Fig. 2, gas entering the converter at 400 C. and 60% conversion reaches 448 C., after passing through 8 in. of catalyst bed.

On all the charts, points of constant percent conversion of  $\text{SO}_2$  to  $\text{SO}_3$  along the temperature lines have been joined as constant conversion lines.

In making up graphs for an existing unit, plant operating data are used to establish the individual activity of catalyst in each stage, using the calculation method developed by Goldman.<sup>2</sup> The plant data needed for this include gas mass velocity, feed gas composition, gas temperature entering and leaving each stage,





catalyst depth in each stage, physical dimensions of the catalyst, and over-all conversion efficiency of the oxidation of  $\text{SO}_2$  to  $\text{SO}_3$ . It should be noted that these graphs are specific for a particular catalyst type and size, gas flow rate, and feed gas composition. Since the catalyst type and size are known for existing converters, and the activity readily calculated, the effect of changes in feed composition and flow rate (production capacity) can be established by the preparation of a limited number of the graphs.

The three graphs are based on the operating data of an existing three-stage converter running at a production rate of 130% of rated capacity on 10%  $\text{SO}_2$  feed gas, using Monsanto vanadium catalyst.

Fig. 1 shows a typical plot of gas temperature vs. catalyst depth for the first converter stage. The retarding influence of slow initial reaction rate and the approach to thermodynamic equilibrium are indicated by the requirement of greater catalyst depth for each incremental change in conversion. Slow reaction rate due to decreased catalytic activity at low temperature results in the need for more depth in the low-conversion range. As the exothermic reaction proceeds, the gas temperature rises and the reaction rate increases rapidly so that the catalyst quantity per unit conversion becomes much less; this region is shown in the chart as the relatively horizontal portion of the curves. Finally, the reaction approaches equilibrium, which is indicated by the rapid increase in depth at higher temperatures.

Figs. 2 and 3 are typical graphs of temperature vs. catalyst depth for the second and third converter stages, respectively. Because of the lower partial pressure of  $\text{SO}_2$ , and the retarding influence of the  $\text{SO}_3$  already formed by the reaction, the catalyst requirement per increment of conversion is considerably greater than for the first stage. The charts are constructed in a manner similar to Fig. 1, but have as a base an inlet gas composition corresponding to a selected degree of conversion. In Fig. 2, the base is 60% conversion, and in Fig. 3, 90%. The catalyst depth for each graph is calculated for each increment in conversion above the base.

To use the graphs, one enters at a selected gas temperature and degree of conversion, and follows the temperature curve to the chosen catalyst depth. At the intersection, the maximum conversion possible with a particular catalyst can be determined visually. For example, in Fig. 1 the gas entering the first stage was assumed to be at 425 C. Following the temperature line to a 15-in. depth, we see that the maximum conversion is 65%. We enter Fig. 2 at 65% conversion and the selected temperature of 415 C. Under these conditions, the starting point is at a depth of 3 in. If the catalyst depth in the second stage is 17 in., the base of 3 in. is added to the 17 in. to give a depth of 20 in. At this depth, the outlet conversion from the second stage is 90%. Similarly, by entering Fig. 3 at the selected 430 C., 96% conversion is the maximum possible for a depth of 20 in.

Once the graphs are prepared for each stage, it is possible to analyze quickly the effect of changes

in feed temperature and catalyst depth or quantity. The result of variations in feed composition, gas flow (production rate), and catalyst type and size, may be determined by reference to a series of the graphs.

Some of the ways in which the graphs have been used in practice are as follows:

- Inlet gas temperature can be chosen to achieve the best use of existing catalyst mass.

- Over-all conversion efficiency possible under chosen conditions of gas inlet temperature and catalyst depth can be established as a base for determining the maximum capacity in existing equipment.

- Effect on over-all conversion of altering operating conditions in any stage can be studied by means of calculation instead of large-scale testing. Important variables include: (1) gas inlet temperature; (2) feed gas composition; (3) production rate; (4) gas velocity; (5) number of stages; (6) catalyst depth; (7) catalyst activity; (8) catalyst size.

- Benefits of employing various combinations of catalyst size and type can be evaluated.

- Most economic catalytic arrangement or distribution can be established for either existing or proposed converters, assuming information on the catalyst activity is available in the plant or from simple laboratory tests.

- Changes in catalytic activity with time can be investigated while the unit is running, to permit planning for replacement or addition of catalyst prior to the shutdown period.

- Operating managers can be guided in deciding whether suggestions for cost reduction or process improvement in the conversion step (usually the economic heart of the unit) are practical and significant.

- Plant designers can be guided in developing more efficient reactors, since they can compare such items as effect of converter diameter on process blower pressure from a firm base of economics. With such comparisons, it should be possible to realize appreciable reductions in cost of reactor facilities.

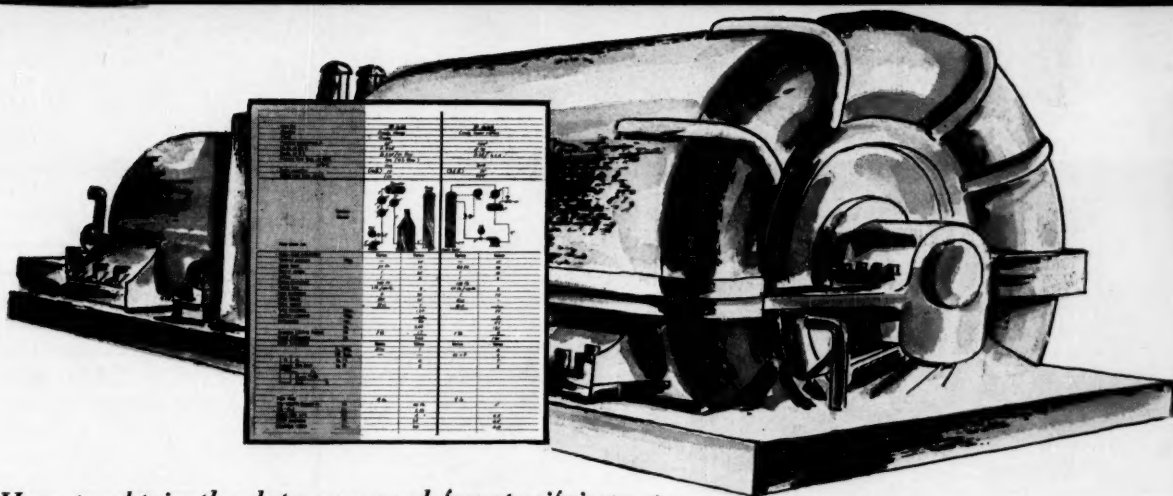
- Plant operators and local authorities both have available in such charts an approach to profitable atmospheric pollution and odor abatement.

## References

1. Donovan, J. R., in "Manufacture of Sulfuric Acid," p. 166-170, edited by Duecker and West, ACS Monograph No. 144, Reinhold Publishing Corp., New York, 1959.
2. Goldman, M., et al, *J. Appl. Chem.*, 7, p. 274-284, May 1957.

## Meet the Author

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*How to obtain the data you need for specifying pumps and compressors. Novel calculation form speeds up determination of pump head requirements and NPSH.*

## Selecting Pumps and Compressors

A. H. YOUNGER and J. L. RUITER, Phillips Petroleum Co., Taylor, B. C.\*

If you are an average engineer, you probably don't specify pumps and compressors, although you do have the responsibility for buying them. Generally, the manufacturer's sales engineer picks the equipment for you by using the data you give him. To choose the right pump for your job, the manufacturer has to know exactly what your requirements are. Here's how to collect or calculate the information he needs.

### Pump Specification

There are seven items of process data that must be specified for pumps. The first four are basic, and can be obtained from the process flowsheet (which should include a heat and material balance) or from tables of physical properties. The basic four process items are:

- Fluid being pumped.
- Operating temperature.
- Specific gravity, both at 60 F. and at operating conditions.

• Viscosity at operating conditions—this is particularly important for positive displacement pumps.

Working up the next three items takes a little more time. These are:

- Capacity.
- Head.
- Net positive suction head (NPSH).

Here are some rules-of-thumb for handling these three items:

► **Capacity**—Normally, use the figure obtained from the process material-balance, plus 10%, to allow for possible process changes. For reflux service, it's best

to add another 25%, since too-little reflux can very easily limit a distillation tower's separating ability.

► **Head**—The form shown in Fig. 1 lists the various heads that have to be taken into account. If exact values are known, use them. If not, the following list will enable you to make reasonable "guesstimates."

**Control Valves**—Use 10 psi., or one-third of the total variable pressure drops in the circuit, whichever is greater.

**Heat Exchangers**—Use 10 psi. for each exchanger in different services. For exchangers with multiple shells in the same service, use 20 psi. for three shells in series, 25 psi. for four or more.

**Furnaces**—Use 25-40 psi.

**Miscellaneous**—It's preferable to use calculated values of pressure drop for reactors, dryers, and the like. If no data are available, figure on at least 5 psi. for each unit.

**Piping Losses**—Use standard values for head losses including valves, elbows, changes in direction, etc.

The total head is calculated as shown in Fig. 1. Don't forget differences in elevation.

Then, to take care of any items that may have been underestimated, add a safety factor of at least 5%.

► **Net positive suction head**—Will it pump, or will it cavitate? The NPSH determines the matter. Be conservative! Cavitation causes loss of head, and may lead to loss of the pump, through impeller erosion.

$$\text{NPSH} = (P_1 - VP) + (H_1 - H_2 - F)$$

Where,

$P_1$  = Actual absolute pressure, ft.

$VP$  = Absolute vapor pressure, ft.

$H_2$  = Minimum liquid level above grade, ft.

$H_1$  = Height of pump (impeller eye) above grade, ft.

$F$  = Friction loss in the piping, ft.

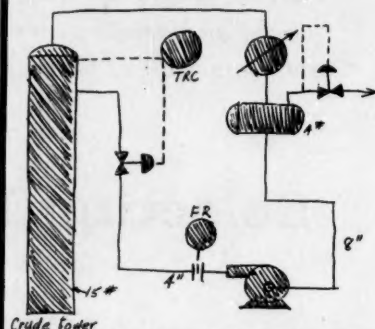
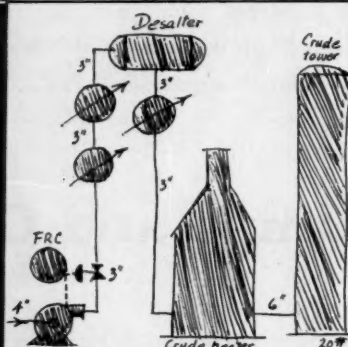
\* Meet your authors, p. 120.

Item No.  
Service  
Fluid  
Pumping temperature, F.  
Sp. Gr. at 60 F.  
Sp. Gr. at P.T.  
Process flow Gpm. at 60 F.  
at P.T.  
Extra capacity  
Rated flow Gpm. at P.T.

P. 601  
Crude charge  
Crude  
60°  
0.835  
0.835/41 SSU.  
100 (U.S. Gpm.)  
100  
(10%) 10  
110

P. 602  
Crude tower reflux  
100°  
0.70  
0.68/0.6 c.s.  
300  
(25%) 75  
375

System  
Sketch



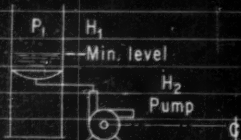
Flow sheet ref.

Pump-head calculation  
Terminal pressure Psig.  
Static head 30 Ft.  
Control valves 1  
Orifice 1  
Piping equivalent 750 Ft.  
Piping loss 3 Ft./100 Ft.  
Heat exchanger 3  
Other losses Est.  
Other losses Est.  
Total discharge Psig.  
Suction-pressure Psig.  
Differential Psi.  
Ft.  
Overplus (Safety factor) Ft.  
Rated differential Ft.

Notes Value  
— 20  
30 Ft. 10  
1 25  
1 2  
750 Ft.  
3 Ft./100 Ft. 8  
3 30  
Est. 25  
Est. 5  
120  
30  
90  
249  
7% 17  
266

Notes Value  
— 15  
80 Ft. 20  
1 10  
1 2  
150 Ft.  
47 Ft./100 Ft. 2  
1 10  
Est. —  
Est. —  
59  
4  
55  
181  
5% 9  
190

NPSH Calculation  
 $P_1$  Psig.  
VP Psig.  
 $H_1$  Ft.  
 $H_2$  Ft.



Notes Value  
Atm. 1  
— —  
4  
2

Notes Value  
At v.P. 4  
4  
7  
2

Pipe size  
( $P_1 - VP$ ) Convert to Ft.  
( $H_1 - H_2$ ) Ft.  
Piping loss (F) Ft.  
NPSH Available Ft.  
Specified NPSH Ft.

4 In. 40 Ft.  
2 Ft.  
4  
38  
20

8 In. 5  
0.5  
4.5  
4.0



## ◀ Pump calculation form—Fig. 1

The calculation is outlined in Fig. 1, at the left.

Whistler,<sup>8</sup> who recently reviewed the whole problem, makes these suggestions:

If the pump curves include both a water and oil value for the NPSH, use the water value in all cases. The oil value applies only in certain highly specialized situations.

For pumping from atmospheric-pressure gasoline tanks, use a vapor pressure halfway between the Reid value of the product and atmospheric pressure (14.7 psi.).

If oil is being pumped from a steam stripper, assume that it is at its boiling point.

If you are pumping from a large tank of boiling liquid in which the level is constantly changing, you have a special problem. A supersaturated liquid may enter the suction piping and may flash. In a case such as this, add at least 3 ft. to the calculated value to compensate for this condition.

### Mechanical Data for Pumps

Some of the important things to specify are noted below. The manufacturer will specify most of the items.

► **Materials of Construction**—If you are pumping a corrosive liquid, corrosion resistance will be the decisive factor in your choice of materials. Where this is not so:

*Pump Case*—Normally use steel, not cast iron, in refinery or chemical process systems.

*Impeller*—Usually use cast iron or bronze.

*Shaft*—An alloy steel of some type is generally preferred.

*Wear Rings*—Let the manufacturer specify these, unless you have special knowledge about the best materials for corrosive conditions that may occur in your process.

► **Mechanical Design**—Most of these items are best left to the manufacturer.

*Case*—Except on large sizes, a vertically split case is usually used.

*Coupling*—Spacer-type coupling is preferred.

*Seal or Packing*—Use mechanical seals for clean, nonabrasive service if the temperature is no more than 250 F. Otherwise use stuffing boxes.

In some cases, with proper flushing, seals can be used up to 450 F.

*Impeller Size*—Always specify at least  $\frac{1}{4}$ -in. less than the maximum size.

► **Driver**—State type of drive required, and power available. For example: steam turbine, 400-psig. steam with 50 deg. superheat available, 65-psig. outlet; or, electric motor, 440 v., 60 cycle, three phase.

Check the power curve for the type of pump (and size of impeller) you are considering. Be sure the driver has a rated horsepower at least as high as the highest power requirement on the pump curve. For

larger pumps, get a driver 10% higher than the design horsepower.

### Compressor Specification

The process data items that have to be specified:

- Gas that is to be compressed.
- Gas properties. Specify the molecular composition, or the molecular weight and  $C_p/C_v$ .
- Gas temperature at suction end of compressor.
- Gas pressure at compressor suction.

The above data are available from the process flowsheet, which contains a heat and material balance, or from handbooks that list physical properties. The heat-capacity ratio,  $C_p/C_v$ , is particularly important as it determines the compressor power required. If the compressor is to be used on more than one gas, the properties of the heaviest gas should be listed.

The other two process conditions that are required when specifying compressors are:

- Flow.
- Discharge pressure.

► **Flow**—This is obtained from the process flowsheet. An overcapacity of 5% above the figure calculated on the flowsheet is normally ample as a contingency factor. State the flow as so many std. cu. ft./day, (SCFD), at 60 F., and a pressure, usually 14.7 psia.

In the case of centrifugal compressors, be sure that the compressor chosen will not be operating below 60% of its capacity, otherwise it may tend to surge.

► **Discharge Pressure**—Obtain the discharge pressure by combining the required terminal pressure and the pressure drops in the system. The form used for calculating pump discharge pressure (Fig. 1) may be used. In estimating the system pressure drop, use the following guides:

*Heat Exchangers*—Use 5 psi. for each shell.

*Control Valves*—Either use one-third of the total pressure drop in the system, or 5 psi., whichever is greater.

*Dryers, Reactors, Etc.*—Wherever possible, calculate these pressure drops. Or, use 5 psi. for each.

*Pipe Friction*—Calculate as for pumps.

*Miscellaneous*—Calculate values where possible. Otherwise, use at least 5 psi. for each unit.

After the total pressure drop has been determined, add the total calculated drop to the suction pressure to find the preliminary discharge pressure. Then, calculate the compression ratio, which is:

Discharge absolute-pressure divided by suction absolute-pressure.

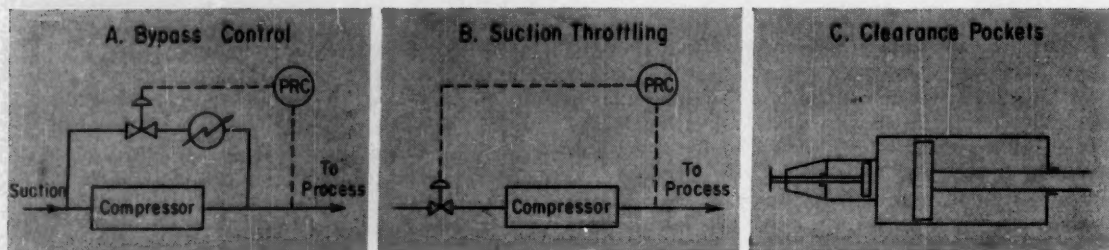
Use the following table to correct the preliminary discharge pressure.

Compression Ratio	Pressure-Drop Increase
6 or less	3%
7 to 36	5%
Over 36	10%

For example, say the suction pressure for a compressor was 20 psia., the calculated pressure drop of the system was 52 psi. and the terminal pressure was 260 psia. Then, the preliminary compression ratio would be:



## Three ways to control compressor output—Fig. 2



$$(52 + 260)/20 = 15.6$$

Thus, the calculated pressure drop would have 52 (0.05) = 2.6, say 3 psi., added to it. The specified discharge pressure would be 55 + 260 = 315 psia. This calculation applies only to the discharge from the compressor. For intercoolers, if they are to be specified, allow a 5-psi. drop for each intercooler.

## Mechanical Data for Reciprocating Compressors

► **Controls**—If the drive is a variable-speed device, such as a steam turbine or d.c. motor, there is no problem in getting capacity control. On the other hand, if the compressor is driven by an a.c. motor, or other constant speed drive, a control will normally be required. The table below lists the kinds of controls usually used, together with their advantages and disadvantages. Some of these controls are illustrated in Fig. 2.

Type of Control	Control Range, %	Horsepower Savings	Remarks
Bypass control	0-100	None	Most expensive—requires control valve piping, cooler, etc., but gives best control.
Suction throttling	25-100	Some	Not as expensive as bypass but gives poorer control.
Suction valve lifters	0-50-100	Considerable	Not too expensive. Good for manual adjustment. Can be automatic.
Clearance pockets	0, 25, 50, 75 and 100	Considerable	Average expense. Gives reasonable variation in flow.

► **Materials of Construction**—Specify steel or cast iron case, if applicable. Materials for piston, shaft, etc., depend on service.

► **Piston Speed**—The reciprocating piston speed of compressors runs about 150 to 800 ft./min. The lower the speed, the better.

► **Other Auxiliaries**—The availability of cooling water (and its temperature), power supply, i. e., steam, gas or electricity (and its characteristics), should be stated.

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4. Hancock, R., *Chem. Eng.*, June 1956, p. 227.
5. Whistler, A. M., *Pet Refiner*, Jan. 1960, p. 175.

## Meet the Authors



A. H. YOUNGER



J. L. RUITER

A. H. YOUNGER is chief engineer of manufacturing for both the Dawson Creek Refinery and McMahon Plant of Pacific Petroleum Ltd. He was a process engineer for Phillips Petroleum Co. on the original design of the McMahon Plant, and then process superintendent on the plant startup. He has also worked for Chemical Construction Corp., and C. F. Brown and Co.

He has a B.A. and an M.A. in chemical engineering from the University of British Columbia and a Ph.D. in chemical engineering from Purdue.

J. L. RUITER is currently with Canadian Bechtel as a senior engineer in the refinery and chemical department. Previously, he was associated with Dr. Younger as a design engineer and design coordinator with Phillips Petroleum and Pacific Petroleum in Taylor, B. C.

He was born and raised in the Dutch East Indies and has a B.Sc. in mechanical engineering.

His initial experience was obtained with the Arabian American Oil Co., with assignments in Dhahran, Saudi Arabia and The Hague, Holland.

# Zeta Potential: New Tool for Water Treatment

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Consulting Engineer and Chemist

The zeta potential (ZP) is a measure of the electrokinetic charge (in millivolts) that surrounds suspended particulate matter.

The charge on raw-water turbidity is predominantly electro-negative, and is strong enough to cause significant mutual repulsion. Thus, raw-water colloids and protein colloids such as skim milk remain suspended. If the charge on these particles is reduced to zero, the repulsive forces are eliminated. Gentle mechanical agitation will then create numerous particle collisions, instead of near-misses, and the forces of adhesion, cohesion and mechanical interlocking will result in agglomeration. The ensuing buildup in particle size then enables rapid settling in accordance with Stokes' law.

## Reappraise Turbidity, Taste and Odor

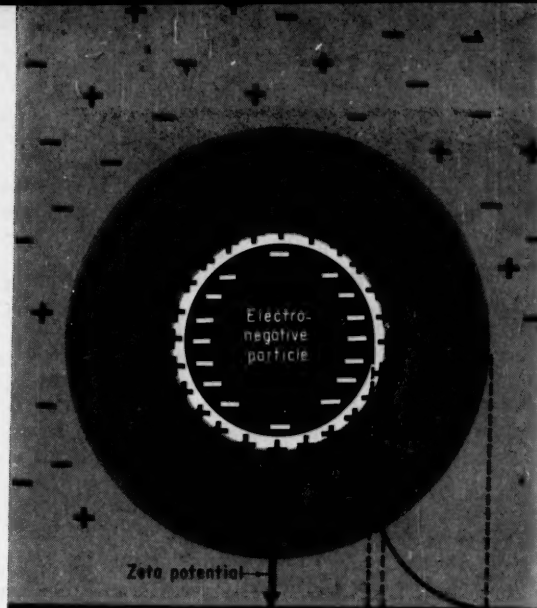
All suspended matter in raw water has historically been considered as "turbidity," regardless of particle size. This consists of finely divided silt and clay and organic matter undergoing microbial decomposition. Included in the latter category are algae, plant proteins and domestic and industrial wastes.

Tastes and odors are predominantly due to the decomposition of organic matter, which releases gases, soluble byproducts and solids of colloidal dimensions to the raw water. Gases may be satisfactorily removed by vigorous aeration and appropriate dosages of activated carbon. Colloid removal, however, requires reduction of the zeta potential.

Our research points to the need for reappraising the present concept of turbidity if a first-quality finished water is to be produced from either polluted or unpolluted sources during profuse algal growth.

Turbidity must be regarded as two distinct and separate fractions, both of which are electro-negative, and consist of:

1. A coarse fraction, ranging in particle diameter from one millimeter to one micron.



*Zeta potential, a long-known principle of physical chemistry, can be used to control the coagulation of difficult raw-water colloids. Although developed for water treatment, the methods described here are applicable to any process where colloids are to be precipitated or dispersed.*

2. A fine (colloidal) fraction, ranging from one micron to 10 Angstrom units.

While the coarse fraction can be successfully removed from raw waters by conventional alum coagulation, the fine fraction cannot. Its colloidal size prevents sedimentation, and its electro-negative zeta potential (in the range of 15 to 25 mv.) prevents agglomeration. Because conventional alum or ferric flocc is also electro-negative, in about the same micro-voltage range, a mutual repulsion exists between the flocc particles and the colloids, and these repelling forces prevent them making permanent contact, regardless of agitation.

We believe that raw-water colloids can be effectively removed only by lowering the zeta potential of both flocc and colloid to a value of approximately zero, plus or minus about 5 mv. This can be done simultaneously by the proper dosage of an inorganic coagulant and an appropriate organic polyelectrolyte.

Both operation and research in depth, at our Waterford, N. Y., water-treatment plant (which we believe to be the first designed and operated on a basis of continuously controlled zeta potential), demonstrate these principles. In this plant, we apply a cationic surfactant about three minutes after application of the alum. This results in appropriate zeta-potential con-

trol and highly satisfactory removal of tastes and odors.

In our approach to the problem of colloidal removal, it was first necessary to devise a simple means of viewing the colloid. As a departure from the conventionally employed electron and ultra microscopes, we devised a new viewing technique employing the stereoscopic microscope, which we will discuss in a second article.

We are now able to visually and qualitatively evaluate the colloid content of both raw and finished waters, using for comparison water distilled at a slow rate.

The colloid must be appraised in the light of both its minute diameter and its relatively large surface area. The range of the human eye is about  $1 \times 10^{-4}$  to about  $1 \times 10^6$  meters, a spread of one to one trillion, while the range of a laboratory microscope is only 1 to 1,000. The range of suspended matter in raw water is about 1 to 1,000,000—the colloid fraction extending from 10 Angstrom units to 1 micron ( $\mu$ ), and the coarse fraction from 1  $\mu$  to 1 mm. Both are spreads of 1,000 to 1.

If we assume that typical floc has a particle diameter approximating 1 mm., then the coarsest colloid has a diameter of only one-thousandth of this, and the finest colloid (invisible to even the electron microscope) has a size ratio to the floc particle of 1 to 1,000,000. These values emphasize the minute sizes of particles with which we must deal.

We noted previously the difficulties in agglomerating and settling finely divided particulate matter. Fig. 1 shows the settling rate of finely crushed silica particles (specific gravity 2.73 @ 20 C.) as calculated from Stokes' law. (It is of course doubtful that any colloid mill could grind silica as fine as 10 Angstrom units.) The curve does show that for the upper colloid range of  $\frac{1}{10} \mu$  to 1  $\mu$  size, sedimentation rates are only 0.03 to 3.4 in. per day, and become negligibly slow towards the lower end of this range.

Furthermore, Stokes' law deals with motion of a particle with respect to water at absolute rest. In all practical situations, however, there will be convection currents in the liquid, resulting from immeasurably small temperature differences, or minor mechanical disturbances, which will be rapid compared to these extremely slow settling rates of colloidal particles. Hence this slow "stirring" of the water is enough to completely overwhelm the settling rate and move the particles up, down or sideways, despite the forces of gravity, if the particles are small enough. The mutually repulsive force, represented by a zeta potential of -25 mv., is enough to keep each particle discrete and prevent the buildup in size required for rapid settlement.

It is noteworthy that while highly polluted waters, such as the Hudson River at Waterford, contain copious amounts of colloids of 0.1  $\mu$  size (with specific gravities approaching unity), appreciable precipitation does occur in less than 30 days. Although this would seem contrary to Stokes' law, there are indications that this settlement is caused by a lowering of the zeta potential of the organic colloids through microbial action. Reduction of repelling forces then results in agglom-

eration to sizes large enough to settle rapidly. We have also observed this phenomenon in samples of raw water and domestic and industrial wastes that had initial ZP values of -15 to -25 mv.

We may summarize these observations by stating that while conventional coagulation (and often plain filtration alone) will satisfactorily remove the coarse fraction of turbidity, it will not remove the colloid. And the colloid must be removed because it is a principal source of taste and odor—and satisfactory removal of taste and odor now constitutes our major (and presently unsolved) water-treatment problem.

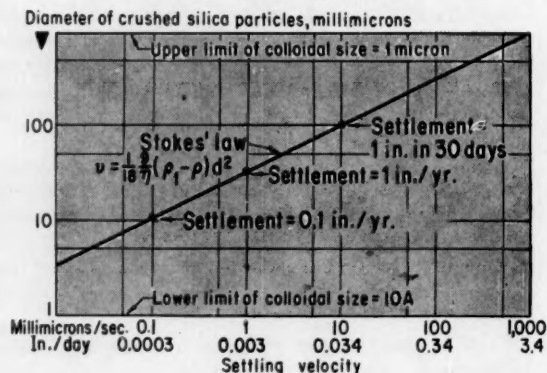
### Reappraise Coagulation Methods

The standard practice of relying upon the jar test or upon visual observation of floc in flocculator bays to establish proper dosage of coagulant in the treatment plant should also be reappraised.

Standard practice has been to set the plant dosage at the minimum required to produce a floc of satisfactory size and settling characteristics. Such floc is invariably electro-negative, and the strength of its charge is sufficient to repel the colloid. The jar test serves only to establish a floc-producing dosage, but floc produced by minimum dosages is far too electro-negative to achieve colloid removal. Therefore, the jar test must be augmented by a determination of the zeta potential of the floc, which can only be effected by means of an electrophoresis cell. The proper coagulant dosages can be established only when the zeta potentials of the floc and colloids are known.

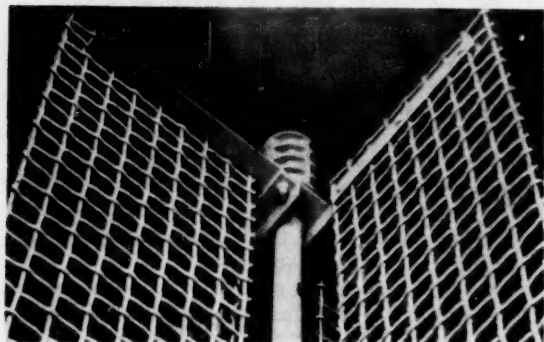
Flocculation is the most delicate and the most important of our water-treatment processes, and the detailing of flocculators and the selection and proper application of coagulating chemicals is the most critical phase of treatment-plant design. With excellent flocculation, a first-quality water can be produced under conditions of heavy overload of sedimentation basins and filters. With indifferent flocculation, a raw water of really poor quality cannot be effectively treated, even at one-tenth the nominal design rate.

### Stokes' law shows that colloids are reluctant settlers—Fig. 1





## Coarse-mesh flocculator causes good mixing of floc and colloid—Fig. 2



A fine-sized floc is normally formed when sufficient alum has been applied to bring the ZP of the floc to about  $-20$  mv. Upon increasing the alum dosage to that representing a carefully operated conventional treatment plant, the ZP will have been reduced to about  $-15$  mv. Since appreciable colloid removal does not take place at this ZP, it is necessary to further lower the ZP to the range of zero,  $\pm 5$  mv.

Although increasing the dosage of alum normally lowers the ZP, raw-water alkalinity is often severely depleted before the ZP has been reduced to zero. If this occurs, unreacted aluminum sulphate will be carried through the plant, and will precipitate in the distribution system, due to normal application of an alkali in the clear-water basin to inhibit corrosion.

Moreover, if alkalinity is lowered to less than about 6 ppm., severe corrosion problems are created that cannot be adequately corrected by application of lime or soda ash to the filter effluent. Polyelectrolytes, on the other hand, effect large changes in ZP without appreciably affecting either alkalinity or pH.

These conditions and limitations, as well as financial considerations, therefore dictate that coagulant dosages be established as follows:

1. A jar test should be run, applying say 20 to 100 ppm. of alum in increments of 20 ppm. (In routine work at Waterford only two dosages are normally required—about 40 and 60 ppm.)

2. A curve should be plotted with alum dosage as the abscissa and ZP as the ordinate. The rate of alum applications in the plant should then be set at the dosage required to bring the ZP to the range of  $-7$  to  $-10$  mv. This dosage should be limited, however, to the amount that will leave a residual alkalinity in the treated water of not less than 6 to 8 ppm. (This is a safeguard against complete depletion of alkalinity, as well as excessive corrosion.)

3. The cationic polyelectrolyte dosage should be adjusted (in the plant or in a jar test) to further lower the ZP to zero. Vary both the alum and the polyelectrolyte daily so that the greatest deviation in ZP in the flocculation basin is  $\pm 5$  mv. The polyelectrolyte dosage will normally range from 0.5 to

about 4 ppm., the former representing waters of low pollution and low organic colloid content and the latter, high organic colloidal loading.

### More Factors Affecting Flocculation

It should not be inferred that the zeta potential is a cure-all for water-treatment ills, or that by zeta-potential control alone we can always achieve flocculation that will fulfill the over-all requirements of large size, toughness, high adsorption and quick settlement. Zeta-potential control eliminates the repulsive forces that prevent the colloid being enmeshed in conventional floc. Other factors that must be taken into account are:

**Flocculator Design**—There should be at least three, and preferably four, flocculation bays in series. Tangential speed of flocculator reels should be individually variable from 0.6 to 1.8 ft./sec., by means of reducers. Over-all detention should not be less than 30, and preferably 40, minutes. The fundamental purpose of flocculators is not to build up large floc quickly, which to some is the principal criterion, but to secure a maximum number of impingements or collisions between the growing floc particles and the raw-water colloids. However, these collisions will result in permanent enmeshments of the colloid only if ZP is low.

It must be borne in mind that raw waters range in colloid concentration from thousands to millions per milliliter. At both our Wanakah (N. Y.) and Waterford treatment plants, we therefore employed coarse wire or plastic mesh (patent applied for) instead of the conventional redwood slats, thereby increasing these collisions many times, compared with conventional design. Fig. 2 shows this new design.

**Use and Application of Chemicals**—Activated silica is necessary for coagulation of many raw waters during certain seasons of the year when natural silica content is low. Silica's function is to bind together and toughen the alum (or ferric) floc complex so that floc particles will build up during continuous agitation. This action is due to formation of a long-chain inorganic polymer, and silica is unique in that it is about the only element normally present in raw water capable of long chain formation. It is best applied about one minute after addition of the prime coagulant.

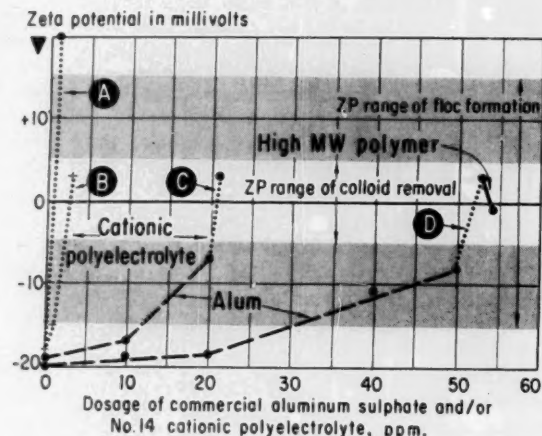
Generally, cationic polyelectrolytes have moderately long chain lengths, with molecular weights ranging up to about 25,000. Although they bind together and toughen the floc complex to a degree, cationics do not supplant silica in this respect. Therefore, both should be applied during the winter months if natural silica content of the raw water is low.

The polymer should be applied approximately three minutes after the application of alum (or alum plus silica). The purpose of this time interval is to first produce microflocs to which the polymer can become attached.

Flocculation should be considered as progressing in three distinct stages: (1) rapid mix and microfloc, (2) colloid gathering and (3) agglomerating. The first stage involves the addition of alum (or ferric salts), followed by silica if needed, and then by the



### Typical curves show zeta-potential control for various waters—Fig. 3



cationic polyelectrolyte. A long rectangular basin with vigorous spiral flow (patent applied for) is preferable to either the circular or rectangular basin, to permit the timed and proper sequence of chemical additions. The over-all detention of the first phase should be in the range of 3 to 5 minutes.

The fundamental purposes of the first stage are to produce tough microflocs of near-zero zeta potential and to bring the ZP of the colloid to near zero. Cationic polyelectrolytes and chlorine react unfavorably. Therefore, it is imperative that the raw water contain no residual chlorine at the time of cationic application. Prechlorination may be employed, provided all chlorine is neutralized with a proper reagent prior to application of the cationic.

Stage two—for enmeshment of the colloid in the gradually building floc—is the most important phase of all water treatment. This phase begins at the entrance to the first flocculation bay and extends through the third.

Detention time should approximate 30 minutes. Unless the colloid is enmeshed in the floc during this stage, little more can be done to prevent its passage through the plant. Here we rely wholly upon zeta-potential control to remove the mutual repulsions existing between colloids, the floc, and also the floc and colloids. It should again be stressed that removal per se of these repelling forces does not produce excellent flocculation but continuous agitation is also necessary.

It is neither necessary nor desirable that floc particles be built up to large size at this stage, because small particles (for any given coagulant dosage) provide a greater total surface area. Flocculation speed should be as high as possible in order to secure a maximum number of impingements, but not so rapid as to arrest floc buildup.

Stage three takes place in the last flocculation bay, where detention should be from 7 to 10 minutes. The sole purpose of this stage is to agglomerate the floc

and build it into large particles that will settle rapidly. This can best be done by introducing a polymer of very long chain and high molecular weight (500,000 to 1,000,000 or more) at the entrance to this bay. Most polymers of this type (natural or synthetic) are anionic and tend to shift the ZP slightly in the electro-negative direction. However, the slightly worsening effect on the zeta potential at this stage is more than counterbalanced by the ability of the long polymer chains to become simultaneously attached to several floc particles. This results in a mechanical as well as electrical interlocking and produces floc of tremendous size, which settles rapidly.

Weighting agents have not received due consideration in the field of coagulation. Although the rate of sedimentation varies directly with particle size, even large-sized floc may settle poorly, due to its inherent low density. This untoward condition can be materially improved by weighting the floc. We accomplish this at both Waterford and Oneonta by mechanically enmeshing very finely divided calcite in the floc during its formation, so that each particle will contain about fifty discrete calcite crystals. Although calcite is electro-negative, its ZP can be adequately controlled by a suitable polyelectrolyte. Barium sulphate is an even better weighting agent because its specific gravity is 4.5, compared with 2.7 for calcite.

### Some Examples of Zeta-Potential Control

Fig. 3 shows typical results of additions of commercial aluminum sulphate (American Water Works Assn. specifications) or cationic polyelectrolyte, or both, to several types of water.

Curve A shows the addition of cationic No. 14\* to distilled water containing about 500 ppm. of finely crushed Ottawa sand. Only 1.0 ppm. was required to change the ZP of the silica colloid from -19 to +20 mv. This very large change in ZP, resulting from a very low dosage of polyelectrolyte, was due to the low degree of ionization of the suspending medium and the fact that the suspensoid was inorganic and unreactive. The specific conductance of the distilled water was 6 micromhos, and was not appreciably increased by addition of the silica.

Curve B shows the change in ZP of raw-water colloids upon addition of cationic No. 14. This was a typical New York City tap sample, which represents unpolluted reservoir water with no chemical treatment other than chlorination. Specific conductance was 125 micromhos. The colloids were predominantly of inorganic origin (finely divided silt). The organic fraction (color, 20 ppm.) was derived from the leaching of decomposing vegetation on the watershed, and decomposing aquatic plants and microbial growths. Three ppm. of cationic No. 14 changed the ZP from -18 to +3. The cationic polyelectrolyte itself could therefore have enabled quasi-autogenous coagulation.

Curve C shows the addition of two successive dosages of alum (10 ppm. each) to this water, which

\* This designates the most-effective cationic polyelectrolyte of about 50 commercial brands evaluated in our laboratory. It is a polyamine.

changed the ZP from -19 to -7 mv. One ppm. of cationic No. 14 then changed the ZP from -19 to +3 mv., resulting in a marked improvement in floc formation, colloid removal and clarity.

Curve D shows the addition of alum and cationic No. 14 to raw Hudson River water collected at Waterford, N. Y. The river receives the discharge of 16 pulp and paper mills within 40 miles upstream, as well as untreated domestic wastes from a watershed population of 150,000.

The combined volume of these wastes varies seasonally from 2 to 13% of total river flow (average run-off, 7,400 cu. ft./sec.). Concentration of organic colloids is very high, and greatly exceeds inorganic colloids. Fifty ppm. of alum was required to change the ZP from -20 to -8 mv., whereas 3 ppm. of cationic No. 14 changed the ZP from -8 to +3 mv. Floc formation was visually evident at 30 ppm. of alum (ZP -15 mv.), slowly improving with successive alum dosages. The addition of the cationic improved floc formation and colloid removal markedly, as evaluated by microscopic and light-scattering techniques. After 20 min. of slow-speed agitation, 0.6 ppm. of a long chain high-molecular-weight polymer (anionic No. 4) was added. This greatly increased the size of floc particles and resulted in rapid settlement. Since the polymer was anionic, the ZP was changed from +3 to -1 mv.

It should be again noted that while floc formation is visually evident at a ZP of about -20 mv., colloids are not effectively removed until the ZP has been further decreased to about -5 mv.

It is beyond the scope of this article to discuss the relationship between the character of raw water and the required alum and polyelectrolyte dosages. It should be pointed out, however, that for any given coagulant and cationic polyelectrolyte, the dosages vary principally with the organic colloid content, alkalinity, pH and dissolved mineral salts of the raw water.

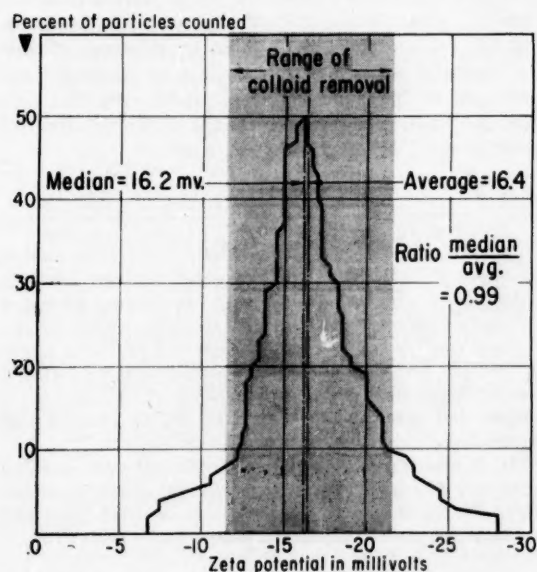
### Zeta Potential Varies Within a System

It should not be inferred that the zeta potentials of discrete colloids constituting a system are all identical. Although such systems are usually reported as a single value (which can be checked within  $\pm 1$  mv. on repeat determinations), this value is actually computed by averaging electrophoretic velocities of say 10 or 20 particles, among which there may be considerable variation. These variations are not adequately shown by timing and individually recording 20 particles, but are clearly revealed if 100 random particles are individually timed. The electric timer that we employ, activated by a very fast-acting switch, enables the basic data for a 100-particle count to be recorded in about ten minutes. (An assistant is of course required to tabulate the readings.) These data form closely reproducible curves, examples of which are shown on Figs. 4 and 5.

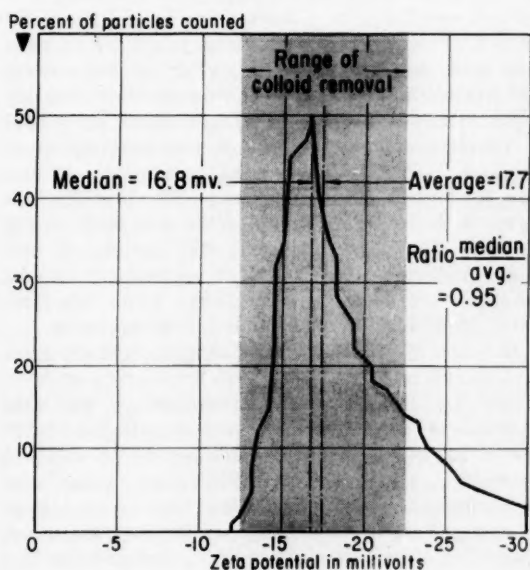
The tree-type curve is well adapted to data of this type, as it shows the relative distribution on both sides of the median. Tree curves of many natural colloids are often quite symmetrical about the median, with the median approximating the average. How-

Tree curves show how zeta potential varies within a colloid system.

New York City tap water—Fig. 4



Raw sugar-cane juice—Fig. 5



ever, this is not invariably the case. Distribution curves of both skim milk and finely crushed silica are similar to Fig. 4. Raw sugar-juice colloids, however, often give a steeply pitched curve from the lower ZP value to the median, and a flatter curve from the median to the maximum ZP, as shown on Fig. 5.

It is obviously impossible to bring all colloids to zero zeta potential in systems similar to the above. In Fig. 4, if the average colloid is brought to zero, then 8% of the lower ZP fraction and 10% of the higher ZP fraction will still lie outside the over-all spread of effective removal of  $\pm 5$  mv. In Fig. 5, this 10-mv. spread would include all colloids on the low ZP side above 2%, but would leave 14% of the high ZP colloids outside the range of effective removal.

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### Next Installment

*This article, the first of two, describes the application of zeta-potential control to water treatment. The second will outline the theory of zeta potential and describe the author's device for measurement of this quantity. It will also describe the successful application of zeta-potential control in the operation of the Waterford, N. Y., water-treatment plant.*

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The best over-all solution is, therefore, to apply a sufficient dosage of inorganic coagulant and polyelectrolyte to bring the average colloid to at least zero, and preferably to a positive value of about 3 mv. This favors removal of the anionic polyelectrolyte (introduced in the last flocculator bay). The anionic polyelectrolyte renders the colloid more electro-negative (by about 3 mv.) when applied at a normal dosage of, say, 0.6 ppm. The colloids in the lower ZP range are readily removed, as they are all brought to or past the zero point and, after agglomerating, they will not again disperse at values around +5 mv.

The practical aspects of this natural spread in ZP values of raw-water colloids are quite apparent in either the jar test or in plant operation. If raw water is flocculated at an average ZP value (of colloids and floc) of zero, most of the floc settles quite rapidly. However, there will still remain a very small percentage of both floc and unenmeshed colloids that settle very slowly, if at all. The ZP of this fraction (represented in plant practice by water on top of the filters) will always be electro-negative, most often in the range of -6 to -10 mv.

This natural limitation in control of the zeta potential of both floc and colloids raises a doubt concerning the statement sometimes made—that in the future, with effective ZP control, filters may be eliminated. We believe that filters will always be required to mechanically strain this fine-sized, nonsettling floc. In our opinion, complete colloid

removal can never be achieved on a practical scale—even by distillation. Control of ZP based on the average colloid (or floc particle), however, will produce first quality water from highly polluted sources.

It should be pointed out that bacterial cells, both dead and alive, have zeta potentials ranging from zero to about -40 mv., with extremes to -80 mv. or more. These cells are quite visible under effective illumination, and undoubtedly dead cells show up in the distribution curves, principally at the extremes. (Motile bacteria are identifiable if they exhibit transverse movement and of course should not be counted). Good technique in determining average electrophoretic mobility dictates that neither the slowest nor fastest particle be counted.

It should also be pointed out that whereas our research shows maximum colloid removal at zero ZP  $\pm 5$  mv., it is quite possible that for some suspensions the optimum may be shifted a few mv. on either side of zero. It is also possible that the effective spread for specific suspensions may vary from  $\pm 5$  mv. In evaluating the fundamental accuracy of the ZP determination, the limitations of the technique and its basic formula should also be borne in mind. These points are well covered by Brinton and Lauffer (in chapter ten of "Electrophoresis," Academic Press, 1959).

We may therefore state that although the zeta potential has its limitations in theory, technique and effectiveness, these are not of a serious nature, as zeta-potential control does enable a very high degree of colloid removal. Opposed to this, present practice in the most efficiently operated water-treatment plants does not result in appreciable colloid removal.

In raw-sugar production and refining, colloids constitute by far the major operating problem. A few scientists and technicians in the sugar field are now becoming aware of this—and of the role of the zeta potential in precipitation.

Colloids are divided into two broad categories: the lyophobic, which have little affinity for water, and the lyophilic, which have great affinity. Control of the zeta potential is undoubtedly the key to effective precipitation of lyophobic colloids. With lyophilic colloids, the additional and sometimes difficult factor of solvation must be taken into full account.

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### Meet the Author

THOMAS M. RIDDICK has conducted his own business as consulting engineer and chemist specializing in water and waste treatment for 25 years. He achieved his B.S. in sanitary engineering from the University of North Carolina in 1932, and then spent short periods with that state's Health Dept., the engineering school of N.Y.U. as a teacher and with Nicholas S. Hill, Jr., as chemist and bacteriologist.

Mr. Riddick's firm has been active in research and has made several patent applications. Recent projects include water-treatment plants for the towns of Waterford and Oneonta and for the Wanakah Water Co.

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## Articles in This New Series

1. Designing laminar-flow systems, June 12, 1961, p. 243.
- 2. Determining End of Laminar Region.
3. Prior art on turbulent flow.
4. Scaleup of non-Newtonian turbulent flow.
5. Handling settling slurries.
6. Methods for obtaining data.
7. How to interpret data.

## Determining End of Laminar Region

*In non-Newtonian flow, the onset of turbulent flow is at different Reynolds numbers for different pipe sizes. Here is how to determine where the turbulent region begins.*

RICHARD LeBARON BOWEN, Jr., Coated Textile Mills, Inc.\*

The treatment in Part I of this series applies specifically to scaleup in the laminar region. Obviously, experimental data taken in the laminar region cannot be used to scaleup into the turbulent region.

Therefore, the present treatment would not be of much value if we did not have some means of predicting the onset of turbulence. For Newtonian fluids, laminar flow ends at a Reynolds number of just about 2,100 or a friction factor of 0.0076 since the two are directly related in the laminar region ( $f = 16/N_{Re}$ ). We can equate the friction factor to the Reynolds number using the viscosity  $\mu$  for Newtonian fluids

$$\frac{D \Delta P}{4L} \left/ \frac{\rho V^2}{2g_c} \right. = \frac{16\mu}{DV\rho} \quad (18)^\dagger$$

This rearranges to the following:

$$g_c(D \Delta P/4L) = \mu(8V/D) \quad (19)$$

This is Poiseuille's law for Newtonian fluids. It indicates that for non-Newtonian fluids,  $\mu$  in the Reynolds number must equal the ratio of  $g_c D \Delta P/4L$ , divided by  $8V/D$ , to calculate a Reynolds number for use on the conventional Reynolds-number chart. It really amounts to putting the major part of the Poiseuille equation in the denominator of the Reynolds number

$$N_{Re}g = \frac{DV\rho}{g_c(D \Delta P/4L)/(8V/D)} \quad (20)$$

This may be considered the most useful generalized

Reynolds number available for non-Newtonian fluids, and it reduces to the usual Reynolds number for Newtonian fluids.

Determining whether scaleup is in the laminar region is a simple matter with this equation. For any specific pipe size, the maximum velocity (and maximum Reynolds number) is found at the maximum value of  $8V/D$ . Therefore, we can equate  $V$  to  $Dg/8$ , where  $g$  is the actual numerical value of  $8V/D$ . With most non-Newtonian fluids where the logarithmic slope of  $(D \Delta P/4L)/(8V/D)$  is less than unity, the ratio of these two quantities decreases with increasing values of  $8V/D$ . So the maximum Reynolds number occurs at the maximum value of  $8V/D$  in the majority of the cases (slope less than unity). And the Reynolds number may be reduced to the following:

$$N_{Re}g' = \frac{\rho D^2 g/8}{g_c e/g} = \frac{\rho D^2 g^2}{257.6e} \quad (21)$$

where  $e$  is the numerical value of  $D \Delta P/4L$  at  $g$ . With a given value of  $8V/D$ , the maximum Reynolds number occurs at the maximum pipe size. Therefore, the largest pipe size used on the pipe-flow chart is used in Eq. (21) to solve for the Reynolds number.

If the Reynolds number should turn out to be well over 2,000 for the largest pipe, Eq. (21) can be equated to 2,000 and solved for  $D$ . This will give the minimum pipe diameter at which turbulence first occurs at the maximum value of  $8V/D$  (turbulence will occur in all larger pipes at this value of  $8V/D$ ).

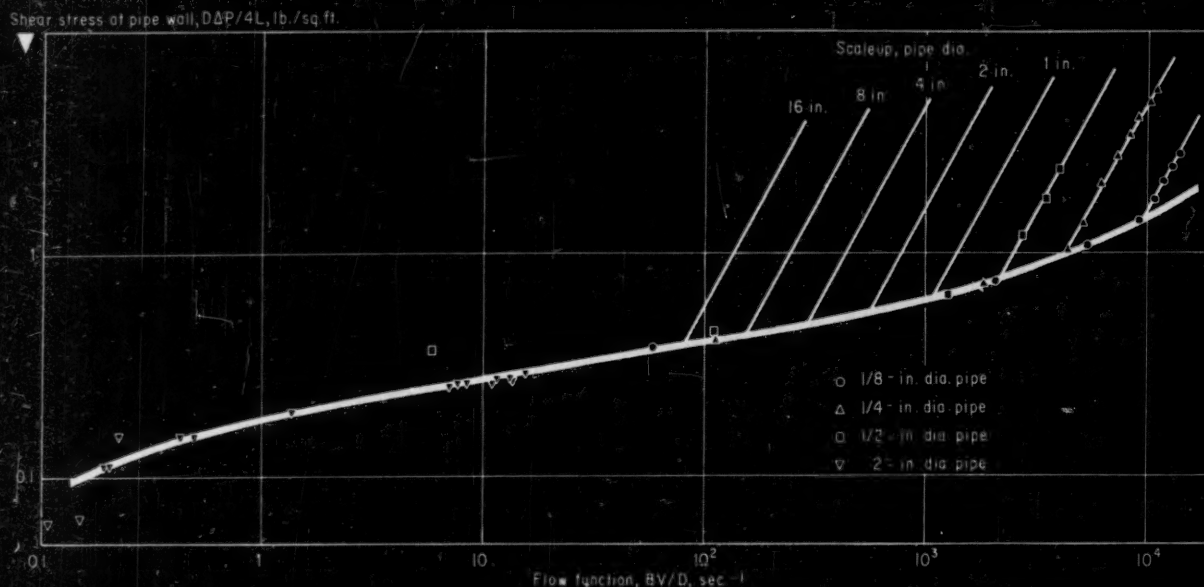
If the logarithmic slope of  $(D \Delta P/4L)/(8V/D)$  is greater than unity, the above procedure must be checked at several values of  $(D \Delta P/4L)/(8V/D)$  to make sure maximum Reynolds number is at maximum  $8V/D$ . If turbulence occurs in a pipe within the range of the pipe-flow curves established (see Fig. 3, Part I) then the point of onset of turbulence for each pipe size must be calculated from Eq. (20) and a line drawn across these on the flow chart.

If any major portion of the pipe-flow curves lies in

\* For author biography, see *Chem. Eng.*, June 12, 1961, p. 248.  
<sup>†</sup> Equation numbering system is continued from Part I of this series.



## Flow chart for 23% lime slurry shows where turbulent flow starts—Fig. 4†



the turbulent region, or if it is desired to scale up a pipe into the turbulent region, another experimental means of collecting the basic data must be used.

With small-diameter tubes and a maximum of 100-psi. gas pressure, there is virtually no chance of getting turbulent data in an extrusion rheometer. Actually, using 100 psi. with a Newtonian fluid in a 1/8-in. tube, 12-in. long, the viscosity would have to be less than 10 cp. to obtain turbulent flow; with a 1/4-in. × 12-in. tube, less than about 100 cp. is required for turbulence. In such cases, the rheometer would empty so fast it would be difficult to obtain any data. However, data taken in the laminar region with small-diameter tubes can quite easily be scaled up to much larger pipes.

## Higher Reynolds Numbers for Viscous Materials

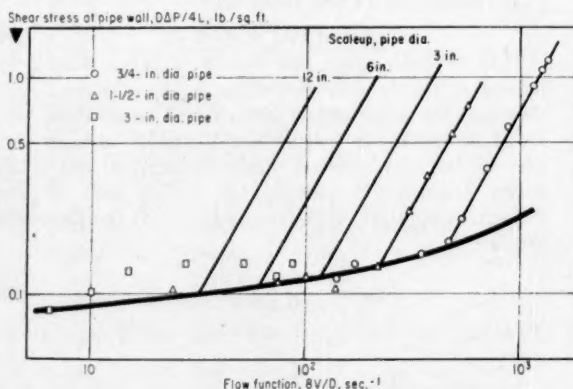
In the above method, we have assumed that the onset of turbulence for non-Newtonian fluids occurs at the same Reynolds number as with Newtonian fluids. In the first work to shed any constructive light on the problem, it was shown that for a wide variety of non-Newtonian fluids the onset of turbulence occurred at about 2,100 when using the conventional friction factor and a generalized Reynolds number<sup>8</sup> defined by Eq. (3) given in Part I of this series:

$$N_{ReM} = \frac{D^n V^{2-n} \rho}{g_c K' 8^{n-1}}$$

† Figure numbering system is continued from Part I of this series.

More recent work using the same Reynolds number has shown quite clearly that the greater the degree of non-Newtonian characteristics certain fluids (pseudoplastics) have, the higher the Reynolds number at which turbulence occurs<sup>9</sup>. However, this increase only carries the laminar region to Reynolds numbers (using Eq. 3) of 3,000 or possibly 4,000 for the most non-Newtonian materials studied. We will show that for certain plastic materials the Reynolds number may ex-

## Onset of turbulence shows up on data from 54.3% cement-rock suspension—Fig. 5



tend to 6,000 or 8,000 using Eq. (20). Therefore, for the present purposes of design in the laminar region, Eqs. (20) or (21) equated to 2,000 will give conservative engineering limits. The laminar region may possibly extend higher in some cases. Only by taking data in the turbulent region can this be determined. We will discuss this problem in considerably more detail in Part IV on non-Newtonian turbulent flow.

### Generalized Equation for Turbulence

In deriving their generalized Reynolds number, Metzner and Reed<sup>8</sup> worked from the Rabinowitsch-Mooney equation,\* defining the derivative  $d \ln(8V/D) / d \ln(D\Delta P/4L)$  as  $1/n'$ , so that  $n'$  is actually the slope of a logarithmic plot of  $D\Delta P/4L$  vs.  $8V/D$ . Since the derivative represents the slope of a line, we can write the relationship for the line.

$$D \Delta P/4L = K'(8V/D)^{n'} \quad (22)$$

If the  $D\Delta P/4L$  vs.  $8V/D$  data happen to fall on a straight line on a logarithmic plot, Eq. (22) is actually the equation of the data line. If the data do not fall on a straight line, Eq. (22) is the equation of a tangent to the curve at any specific point. Thus, the two quantities may be related by this equation, whether the data describe a straight line or not. If the data do not form a straight line, point values of the constants  $K'$  and  $n'$  must be determined at each value of  $8V/D$ .

Metzner and Reed and others noted that the friction factor for Newtonians equals  $16/N_{Re}$ :

$$\frac{D \Delta P/4L}{\rho V^2/2g_c} = \frac{16}{N_{Re}} \quad (23)$$

They substituted Eq. (22) into this and solved for the Reynolds number for non-Newtonians:

$$\frac{K'(8V/D)^{n'}}{\rho V^2/2g_c} = \frac{16}{N_{Re}}$$

\* Eq. 11, Part 1, *Chem. Eng.*, June 12, p. 245.

$$N_{ReM} = \frac{16D^{n'}V^2\rho}{2g_cK'8^{n'}V^{n'}} = \frac{D^{n'}V^{2-n'}\rho}{g_cK'8^{n'-1}} \quad (24)$$

If we now return to Eq. (20), and substitute Eq. (22) into it, it also reduces to Eq. (24). But it may be more usefully rearranged in a slightly different form

$$\begin{aligned} N_{ReG} &= \frac{DV\rho}{g_cK'(8V/D)^{n'}/(8V/D)} \\ &= \frac{DV\rho}{g_cK'(8V/D)^{n'-1}} \end{aligned} \quad (25)$$

Eq. (20) is in a more generalized form than Eq. (24), since it is not necessary to calculate values of  $K'$  and  $n'$  for each measurement in cases where  $K'$  and  $n'$  are not constant over the range of the data.

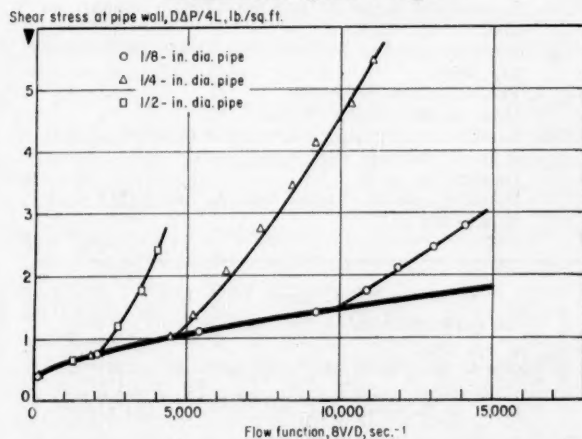
The denominator of the Reynolds number in Eq. (20) is calculated very simply from pressure drop, velocity, and pipe diameter and length. Actual numerical values of the terms  $D\Delta P/4L$  and  $8V/D$  come, of course, from the plot of these values. Eq. (25) is also in a simpler form than Eq. (24), since only one term has an exponent.

### Turbulent Data Not on One Curve

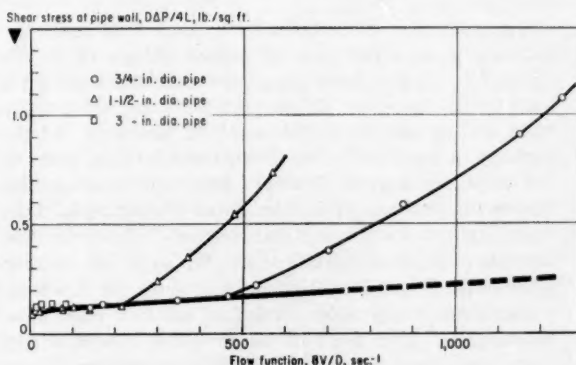
However, when the Reynolds number is arranged in the form of Eq. (20), which is identical to either Eq. (24) or (25) and reduces to the conventional form of  $DV\rho/\mu$  for Newtonian fluids, there is a serious question as to whether it gives a clear picture of the laminar region. It can be rearranged as shown in the equations below:

$$\begin{aligned} N_{ReG} &= \frac{DV\rho}{g_c(D \Delta P/4L)/(8V/D)} \\ &= \frac{8\rho V^2/g_c}{D \Delta P/4L} \\ &= \frac{16\rho V^2/2g_c}{D \Delta P/4L} \end{aligned} \quad (26)$$

Basic data for 23% lime slurry on arithmetic plot—Fig. 6



Basic data for 54.3% cement-rock suspension on arithmetic plot—Fig. 7



Thus, the actual terms in the generalized Reynolds number reduce to nothing more than the reciprocal of the friction factor times 16. This is also true for Newtonian fluids, because in this case  $8V/D$  is numerically equal to  $(dv/dr)$  so that viscosity is equal to  $g_0(D\Delta P/4L)/(8V/D)$ . The significance of the constant 16 in the equation  $f = 16/N_{Re}$ , becomes quite apparent. Further, it is evident why this relation produces a line with a slope of  $-1$  on logarithmic coordinates: it is a symmetrical hyperbola of the form  $y = x^{-1}$ , which is the same as plotting  $x$  vs.  $1/x$ . It is also evident why this straight line does not continue into the turbulent region. Here the turbulent value of the shear-stress  $(D\Delta P/4L)$  is used in the friction factor (determined from the actual pressure drop), while the laminar value of  $D\Delta P/4L$  is used in the Reynolds number (at the specific  $8V/D$ ).

### Shear-Stress Goes Up

The significance of the onset of turbulence now becomes somewhat clearer. It is the point in any pipe at which the shear-stress at the pipe wall starts to increase markedly over what it would be in a smaller pipe (at the same  $8V/D$ ). This is best understood by examining some  $D\Delta P/4L$  vs.  $8V/D$  plots showing what happens when flow in different size pipes becomes turbulent.

The first of these graphs represents a 23% lime slurry in water, used by Alves et al.<sup>1</sup> and has been calculated from the actual data (Fig. 4).<sup>1</sup>

The other shows a 54.3% cement-rock suspension in water (Fig. 5), and has been taken from data published by Wilhelm, et al.,<sup>2</sup> which was in turn used by Hedstrom.<sup>4</sup> These latter data have considerable historical interest, being used by Hedstrom to check his friction factor vs. Reynolds number correlation. In the laminar region, the data of Alves et al. for four pipe sizes ( $\frac{1}{8}$ -in. to 2-in.) correlate very nicely on a line running across the logarithmic plot. The shape of this line has been taken from an extrapolation of the data at higher values of  $8V/D$  on an arithmetic plot (Fig. 6).

A similar correlation is obtained from the data of Wilhelm, et al., for three pipe sizes ( $\frac{1}{8}$ -in. to 3-in.), although the data are somewhat more scattered at lower values of  $8V/D$ .

An arithmetic plot shows that these data probably describe a straight line at higher values of  $8V/D$  (Fig. 7). It has been suggested that the 3-in. pipe used by Wilhelm, et al. did not give correct results with water, and thus this part of the data should perhaps be omitted.<sup>6</sup> But this particular argument is not valid, since the 3-in. water data were taken in the turbulent region, while the 3-in. cement-rock data were limited to the laminar region. However, the laminar 3-in. data do fall above the data for smaller pipe sizes (Figs. 5 and 7) and the shape of the 3-in. curve gives every indication that settling may have taken place. For both of these fluids, branches rise from the lower curves at increasingly higher values of  $8V/D$  for progressively smaller pipe sizes.

### Laminar Flow Persists in Small Pipe

It is evident from these graphs that laminar flow persists at higher and higher values of  $8V/D$  for smaller and smaller pipe sizes. Of course, with these suspensions we can expect anomalous flow characteristics when the tube diameter is reduced so that the particle diameters become a sizable percentage of the tube diameter.

These graphs show clearly that shear-stress at the pipe wall in turbulent flow rises very rapidly so that it may easily be many times greater than in a smaller pipe at the same  $8V/D$ . The friction factor and our generalized Reynolds number (Eq. 26) are both actually a ratio of forces—the viscous shear force (per unit wall area) divided by the main stream inertial force (per unit cross-sectional area). In the turbulent region, this ratio is much greater than in the laminar region (for similar values of  $8V/D$ ). This is why pipe roughness is so critical in turbulent, but not in laminar, flow.

These graphs also emphasize clearly that turbulent data for any fluid in different pipe sizes do not correlate on a single  $D\Delta P/4L$  vs.  $8V/D$  plot, so the data cannot be used for turbulent scaleup in this form. Heretofore, turbulent data have been correlated on a Reynolds-number chart.

### Nomenclature

$D$	Pipe or tube diameter, ft.
$e$	Constant in Eq. (21), equal to value of $D\Delta P/4L$ at $g$ .
$f$	Fanning friction factor (dimensionless) $D\Delta P/4L/\rho V^2/2g_0$ .
$g$	Constant in Eq. (21), equal to $8V/D$ at maximum flow.
$g_0$	Gravitational constant, 32.2 (ft./sec.)/(sec).
$K'$	Fluid consistency index, defined by Eq. (22).
$L$	Pipe or tube length, ft.
$n'$	Non-Newtonian rheological constant defined by Eq. (22).
$N_{Re}$	Conventional Reynolds number, $DV\rho/\mu$ .
$N_{Re0}$	Generalized Reynolds number (dimensionless) defined by Eq. (20).
$N_{Re0'}$	Reynolds number (dimensionless), $\rho D^2 g^2/257.6e$ .
$N_{Re0''}$	Generalized Reynolds number (dimensionless) defined by Eq. (25).
$N_{ReM}$	Reynolds number (dimensionless) used by Metzner and Reed.
$\Delta P$	Pressure drop, lb./sq. ft.
$V$	Mean linear velocity, ft./sec.
$dv/dr$	Local velocity gradient or rate of shear in pipeline or in a rotational viscometer, sec. <sup>-1</sup> .
$\rho$	Density, lb./cu. ft.
$\mu$	Viscosity of a Newtonian fluid, lb./sec. (ft.) equal to $g_0\tau/(dv/dr)$ .

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5. Metzner, A. B., Reed, J. C., *AIChE Jour.*, **1**, 424 (1955).
6. Wilhelm, R. H., others, *Ind. Eng. Chem.*, **31**, 622 (1939).



# Simultaneous Transfer of Heat and Mass

## Part II

JESSE COATES and BERNARD S. PRESSBURG  
Louisiana State University

While the principles and differential balances for humidification (*Chem. Eng.*, May 29, pp. 95-100) can be applied to dehumidification and water cooling, their mathematical solution is more difficult because the water temperature cannot remain constant. Formal integration is substantially impossible even though the units are operated in a countercurrent fashion. Let's amplify these statements by looking at the operations separately. Then, let's see how they can be handled.

Dehumidification is the transfer of water vapor from the air to the liquid phase. It is the opposite of humidification in that the partial pressure of the water vapor is higher in the air than at the interface. Thus:

$$dN = k_H a S dz(H - H_i) = w' dH \quad (1)$$

By definition of the dew point, this can be true only if the water temperature at the interface is below that of the gas. Accordingly, sensible heat is transferred from the gas to the interface. Since the water vapor removed also gives up latent heat at the interface, these two effects are additive. Hence, the water temperature must rise:

$$d(q_{\text{sens.}})_g = w' C_H dt = h_g a S dz(t - t_i) \quad (2)$$

$$d(q_{\text{sens.}})_L = w' \lambda dH + w' C_H dt = L dT \quad (3)$$

The heat quantity given by Eq. (3) must move from the interface to the bulk of the liquid through its laminar boundary layer. Hence:

$$d(q_{\text{sens.}})_L = h_L a S dz(t_i - T) \quad (4)$$

On the basis that  $h_L a$  is very large as compared with  $h_g a$ , it is usually considered that  $t_i$  is the same as the bulk water temperature  $T$ . A more exact criterion for this assumption would be comparison of  $d(q_{\text{sens.}})_L/h_L a$  and  $d(q_{\text{sens.}})_g/h_g a$ . [Note that in adiabatic humidification,  $d(q_{\text{sens.}})_L$  is zero, and therefore  $t_i$  is exactly the same as  $T$  regardless of flow conditions that would determine the relative values of the heat transfer coefficients.]

Integration of these equations to find the total length of the contact path, required for changing  $H_i$  to  $H_o$ , can be accomplished by taking short increments, in

*Special methods are necessary to analyze the processes for air dehumidification or for water cooling by contact with air.*

each of which the liquid-phase temperature can be considered constant. After the transfer rate equations are applied to find the quantity of sensible heat and mass that are transferred in the increment, the heat and material balance equations are applied to find the conditions at the other end of this incremental section. Since these conditions enter into the mean driving force, a great number of increments must be used. Otherwise, the procedure is inherently trial and error. An excellent example is presented by Brown.<sup>1</sup>

A less precise but quicker solution results if this procedure is applied to the over-all column, as illustrated by Problem 1. Use of the logarithmic mean driving force is the major uncertainty and can lead to serious error under certain circumstances.

**Problem 1**—Water at 40 F. is used in a countercurrent contactor to dehumidify air that has a dry bulb temperature of 130 F. and a dew point of 90 F. Air flow rate is 1,200 lb./ (hr.) (sq. ft.) and water flow rate is 1,150 lb./ (hr.) (sq. ft.), both taken at their point of entry into the column. The resulting mass transfer coefficient is 1,240 lb./ (hr.) (sq. ft.) ( $\Delta H$ ).

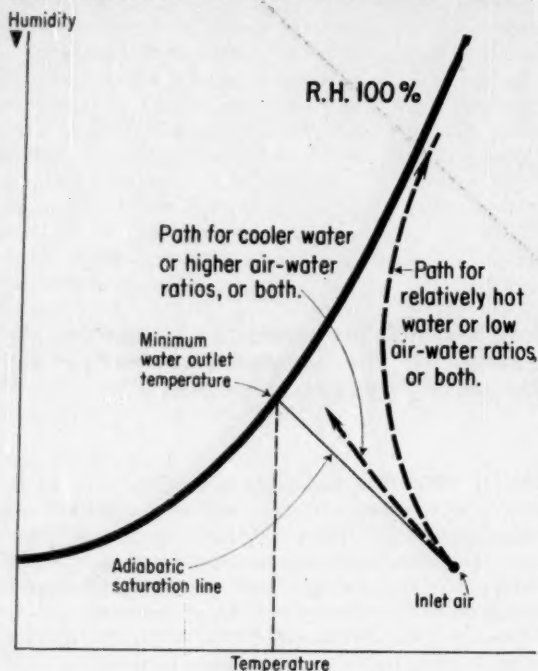
How high must the column be if the air is to leave at a temperature of approximately 50 F. with a dew point of 45 F.? (Exact value of exit temperature would be determined by corresponding heat transfer equations.) Assume the water-phase resistance to heat transfer to be negligible.

For the analysis of this problem, use a column area of 1 sq. ft. as the basis. First, make a heat balance to determine the water outlet temperature. From a psychrometric chart, the humidity of the incoming air is 0.0311 lb. water/lb. bone-dry air. Hence, the incoming air contains 1,200/0.0311, or 1,164 lb., of bone-dry air, having an enthalpy of 64.91 Btu./lb.

Air leaving at 50 F. and a dew point of 45 F. has a humidity of 0.0063 lb. water/lb. bone-dry air and an enthalpy of 18.71 Btu./lb. (Enthalpy from Perry's "Chemical Engineers' Handbook," 3rd ed., McGraw-Hill, 1950.) A material balance gives the water vapor that is removed as the difference between entering humidity and leaving humidity (0.0311 - 0.0063) or 0.0248 lb. water/lb. bone-dry air. Total weight of water



Inlet conditions control humidity—Fig. 1



removed is  $0.0248 \times 1,164$  or 29 lb. Hence, water leaving column equals 1,179 lb.

From an enthalpy balance, we calculate the water outlet temperature  $T_1$ :

$$1,164(64.91 - 18.71) = 1,179(T_1 - 32) - 1,150(40 - 32)$$

$$T_1 = 85.4 \text{ F.}$$

Next, solve for  $Z$ :

$$N = k_H a S Z \Delta H_{LM}$$

$$29 = 1,240 \times 1 \times Z \times 0.00229$$

Therefore, height of a tower  $Z$  is 10.2 ft. In calculating log mean humidity difference, humidities at entrance and exit conditions were:  $H_{w1} = 0.0270$  for  $T_1 = 85.4 \text{ F.}$ ,  $H_{w2} = 0.0052$  for  $T_2 = 40 \text{ F.}$ ,  $H_1 = 0.0311$  for 90 F. dew point and  $H_2 = 0.0063$  for 45 F. dew point.

### Water Cooling by Contact With Air

Water cooling can be considered as nonadiabatic humidification. As long as the water in contact with air is above the wet-bulb temperature of the air, more heat is consumed in vaporizing the water than can be transferred from the air to the water. The difference in these heat quantities is drawn from the liquid, and its temperature falls.

At all points in the tower, the air is humidified as indicated by its path on the humidity diagram shown in Fig. 1. However, sensible heat may be transferred from the air to the water near the bottom of the tower and from the water to the air near the top of the same unit.

Nevertheless, the differential equations still hold,

just as they did for adiabatic humidification and dehumidification. Their solution by increments may be carried out as suggested for dehumidification. Because the direction of sensible heat exchange with the gas phase may be reversed within the tower, the use of the over-all method shown in Problem 1 is unsound.

The relatively recent development of enthalpy as a driving force, and the resultant treatment of both dehumidifiers and water coolers by the NTU-HTU concept, are much more satisfactory.

Briefly, this method notes that the total enthalpy of the air can be evaluated with respect to some specified reference condition as:

$$i_a = \lambda_a H + C_H(t - t_a) \quad (5)$$

This relation is shown in Fig. 2. Note that the adiabatic saturation lines, which slope in the conventional humidity chart, are horizontal here and meet the equilibrium (saturation) line at the adiabatic saturation temperature.

Combining Eq. (5) with the differential material and heat balance equations gives Eq. (6), which is the equation for the enthalpy operating line.

$$dN = k_H a S dz(H - H_i) = w' dH$$

$$d(q_{\text{ent}})_a = -w' C_H dt = h_a a S dz$$

$$i_a = i_{a1} + (T - T_1) LC_L / w' \quad (6)$$

As in absorption, the slope of this line depends on the  $L/w'$  ratio and is, in most cases, nearly straight. This affords a convenient means of finding the minimum water in dehumidifiers, or the minimum air rate in water coolers.

Note that in water cooling, this operating line falls below the equilibrium line and the minimum may be set by tangency of the operating and equilibrium lines at an intermediate position. In dehumidification, the operating line falls above the equilibrium line and the minimum water rate is determined by the point at which it crosses the equilibrium line at the bottom of the column.

For purposes of sizing these units, it can be shown that at a specific point in the column:

$$w' di_a = k_H a S dz(i_i - i_a) = \frac{h_a a S}{C_H} (i_i - i_a) dz \quad (7)$$

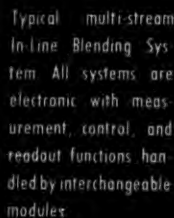
The corresponding integral form of Eq. (7) is:

$$Z = \frac{w'/S}{k_H a} \int_{i_{a1}}^{i_{a2}} \frac{di_a}{(i_i - i_a)} = \frac{C_H(w'/S)}{h_a a} \int_{i_{a1}}^{i_{a2}} \frac{di_a}{(i_i - i_a)} \quad (8)$$

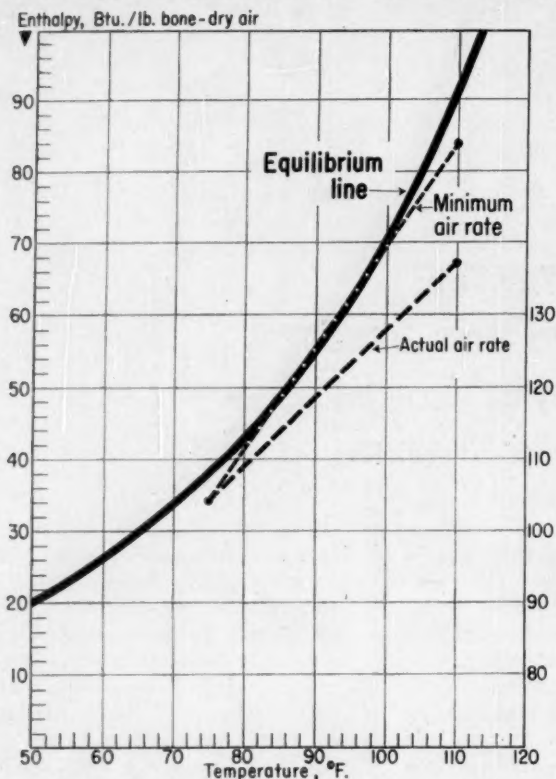
As in dehumidification, solving Eq. (8) for a cooling tower requires the assumption that the interface temperature is that of the water phase. If this assumption is not made, additional manipulations are necessary to establish the interface temperature by use of the liquid-phase heat transfer coefficient.

The first term in Eq. (8) has net units of feet and is the height of a transfer unit, HTU; while the integral is a dimensionless group and is the number of transfer units, NTU. As illustrated in Problem 2, the significance of these terms and the methods of evaluating them are exactly the same as previously discussed for absorber design.<sup>2</sup>

This method is most satisfactory but has one draw-



## Enthalpy-temperature data for air—Fig. 2



back. It gives an outlet enthalpy for the air stream but does not determine which of an infinite number of combinations of temperature and humidity that could give this value actually occurs. If this were a critical point of information, it would have to be determined by the incremental procedure or by modifying the enthalpy method as suggested by Mickley.<sup>3</sup>

**Problem 2**—Using the enthalpy diagram in Fig. 2, determine (1) minimum volumetric rate at which air

can be used to cool 1,000 cfm. water from 110 F. to 75 F. if the air enters the cooling tower at 90 F. and has a wet bulb temperature of 70 F., and (2) tower height if 1.5 times minimum is used.

Let the flow rate of bone-dry air be 750 lb./hr. (sq. ft.) and the corresponding heat and mass transfer coefficients be 63 Btu./hr. (sq. ft.) (°F.) and 250 lb./hr. (sq. ft.) ( $\Delta H$ ), respectively. Neglect liquid-phase heat transfer resistance.

1. In Fig. 2, the tangent line corresponds to maximum  $L/G$  ratio. It is drawn from  $T_1$  (75 F.) and  $i_{s1}$  (34 Btu./lb. bone-dry air, which corresponds to 70 F. wet bulb and adiabatic saturation temperatures) to  $T_2$  (110 F.) and  $i_{s2}$  (84 Btu./lb.). In this specific case,  $L/G_{max}$  is determined by the tangent to the enthalpy-temperature curve. Since  $i_{s2}$  is less than  $i_{s2}^*$  (for 110 F.), the exit air is unsaturated. Minimum air rate can be calculated to be 174,500 lb. bone-dry air/hr., or 40,900 cfm., at the inlet conditions.

2. For 50% more air, the corresponding operating line is shown on Fig. 2 as a dotted line. Note that it can be plotted by determining  $i_{s1}$  (67.3 Btu./lb.) by an enthalpy balance for the same values of  $T_1$  and  $T_2$ .

From Eq. (8), we calculate the HTU and NTU:

$$HTU = \frac{750}{250} = \frac{0.252 \times 750}{63} = 3.0 \text{ ft.}$$

By graphical integration as illustrated in the absorber refresher articles,<sup>2</sup> we evaluate the integral in Eq. (8) to find:

$$NTU = \int \frac{d_{ig}}{i_w - i_g} = 4.0 \text{ ft.}$$

Therefore, height of tower  $Z$  equals HTU multiplied by NTU, or 12 ft.

## References

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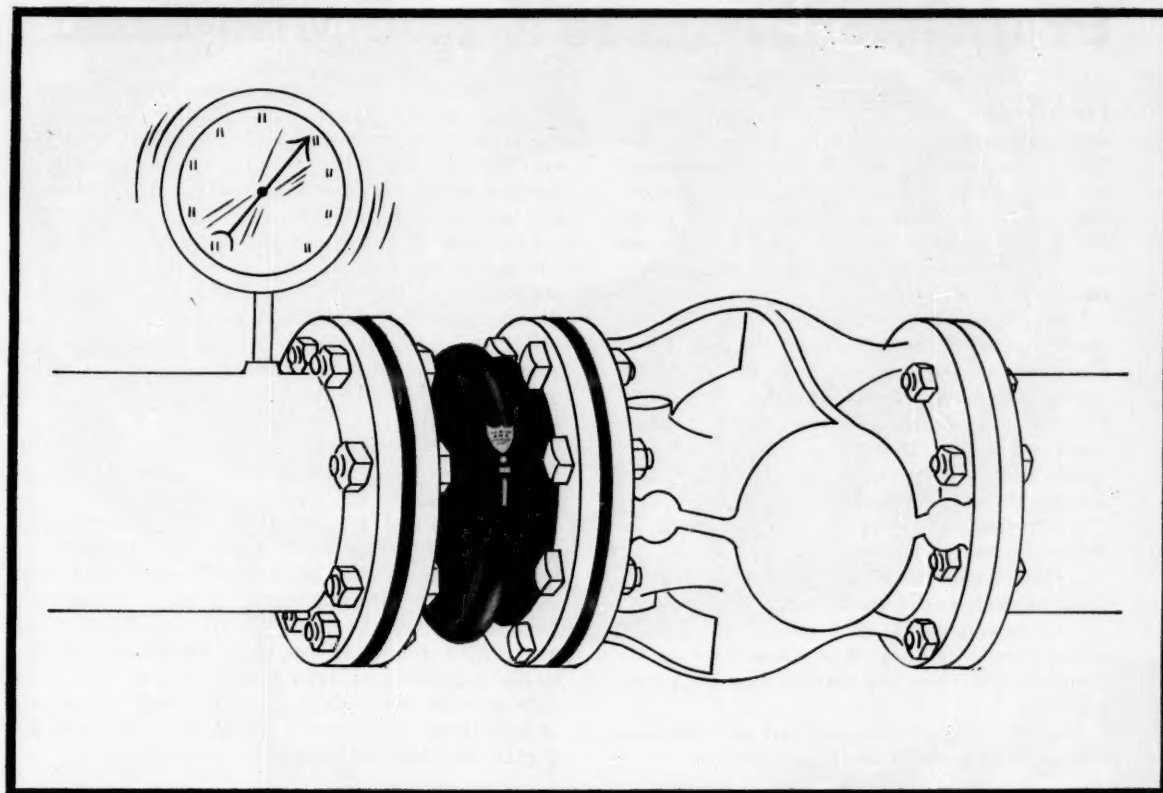
## Nomenclature

$a$	Transfer area, sq. ft./cu. ft. of contact volume.
$C$	Specific heat, Btu./lb. (°F.).
$C_H$	Humid heat, Btu./lb. bone-dry air (°F.).
$G$	Gas phase flow rate, lb./hr. or lb.-mole/hr.
$H$	Humidity, lb. water vapor/lb. bone-dry air.
$h$	Heat transfer coefficient, Btu./hr. (sq. ft.) (°F.).
$i$	Enthalpy, Btu./lb.
$k$	Mass transfer coefficient.
$k_g$	Mass transfer coefficient, lb.-mole/(hr.) (sq. ft.) (atm.).
$k_H$	Mass transfer coefficient, lb.-mole/(hr.) (sq. ft.) ( $\Delta H$ ).
$L$	Liquid phase flow rate, lb./hr. or lb.-mole/hr.
$N$	Mass transfer rate, lb./hr. or lb.-mole/hr.
$q$	Heat transfer rate, Btu./hr.
$S$	Cross sectional area for flow, sq. ft.

$T$	Temperature of liquid phase, °F.
$t$	Temperature of gas phase, °F.
$w$	Weight rate of flow of gas phase, lb./hr.
$w'$	Weight rate of solute-free gas, lb./hr.
$Z$	Height of contacting chamber, ft.
$z$	Distance along path of gas flow, ft.
$\lambda$	Latent heat of vaporization, Btu./lb.

## Subscripts

0	Reference
1	Gas inlet end of contacting chamber.
2	Gas outlet end of contacting chamber.
$g$	Gas phase.
$i$	At interface conditions.
$L$	Liquid phase.



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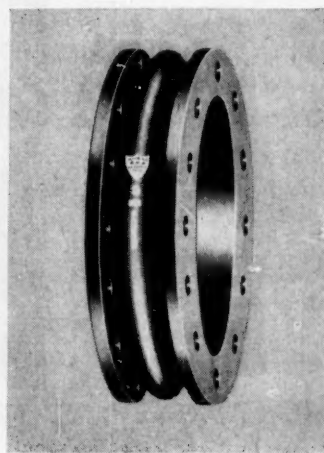
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## Professionalism Is a Two-Mile Road

Thirteen years ago, W. E. Wickenden cast an analogy to professional conduct of engineers that is now considered almost classic. He described the first mile of your calling as one of compulsions, of the required effort you must put forth. But beyond the first mile, he said, is the second mile, which any professional has to trod to attain dignity and distinction.

Now, a chemical engineer, who is an educator, takes a new look at the problem of professionalism for the employed engineer. Without minimizing the efforts that the individual must make, Professor Cunningham also points up the equally important efforts that the employing company must exert to complement individual initiative. Among the important points:

- Professional status is a result of dedication and acceptance of responsibility.
- Continuing competence, translated into accomplishment, is a hallmark of professionalism.
- Encouragement of technical and professional growth is an area of importance to the company, and there are several ways to accomplish it.

Read on to see why you can't sit back and wait for recognition and status to seek you.

WILLIAM A. CUNNINGHAM  
University of Texas



Volumes of words have been written on "professionalism" and related topics, most about as inconclusive and confusing as last year's pre-election opinion polls. One more discussion of professional conduct isn't likely to persuade or dissuade anyone.

Let's confine the discussion to those factors most commonly encountered by chemical engineers in their professional activities. And a good point of departure is W. E. Wickenden's paper, "The Second Mile," which was first presented at a meeting of the Engineering Institute of Canada in 1948, and which was published by Engineers' Council for Professional Development.

Taking his thesis from the Sermon on the Mount ("Whosoever shall compel thee to go one mile, go with him twain"), Dr. Wickenden wrote:

"Every calling has its mile of compulsions, its daily round of tasks and duties, its standards of honest craftsmanship, its code of man-to-man relations, which one must cover if he is to survive. Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance. It is only in this second mile that a calling may attain to the dignity and the distinction of a profession."

### More Than an Individual Task

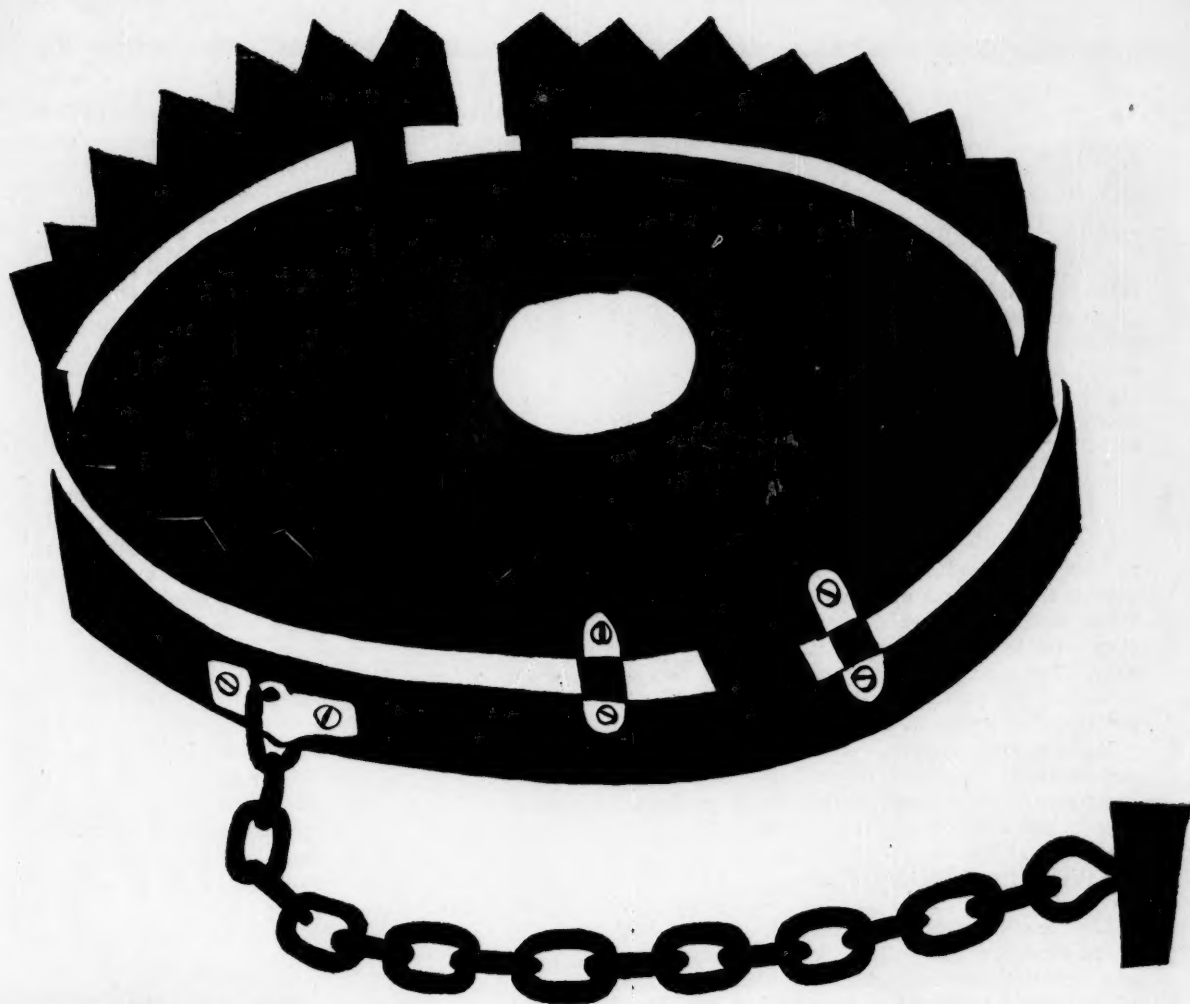
The work of most engineers and scientists involves group effort, in contrast to the personal service of a physician, a lawyer or a clergyman. Most of the technical man's work is done while he is an employee whose ability has been purchased by payment of a regular salary.

Since far more than the individual is concerned, as with the physician or lawyer, professional conduct of the engineer is more complex. But the objectives continue to be those characteristic of the "second mile." One specific account of these objectives that I like is included in the booklet "Professional Standards," published by AIChE in 1955:

"The professional person is an individual who, with adequate training, experience, intellectual capacity and moral integrity, effectively devotes his skills and knowledge to the service of society and his profession in whatever assignment he finds himself involved, being fully sensible of the personal responsibility and trusteeship conferred by his special training."

Like other definitions, the AIChE statement concerns service—to society and to the profession. Frequently, the first is considered to include such things

Based on a talk delivered at the joint meeting of the Texas-Louisiana Gulf section of ACS and the Sabine area section of AIChE at Beaumont, Tex., Mar. 10, 1961.



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*"Productive thinking is quickly stifled by intellectual isolationism. Where direction and information come only from supervisors, colleagues and in-plant experience, intellectual inbreeding inevitably results."*



as church work, P.T.A., Boy Scout leadership, support of United Fund, or other civic service. Though these worthy services deserve the support of all, they mark the citizen and not the professional engineer. The service of a professional man to society is use of his particular skills and ability for that society in which he lives.

But the same criteria apply equally well to individuals and to the organizations that employ them. All must go the second mile if they are to warrant the dignity and distinction of a profession.

### What Can the Individual Do?

Look first at some of the characteristics of professional conduct of the individual. Though one's concept of a principle is often broader or clearer when thought of in general terms, some specifics can help identify features of the principle. Thus, the following list isn't intended to encompass all aspects of professional conduct.

- You can't achieve professional status unless you have a dedicated desire to do so. An attitude that causes you to seek and follow an ethical and moral path, that causes you to consider how your acts affect society, that causes you to accept responsibility for your actions, is a prerequisite to all other professional characteristics.

- As a professional, you recognize clearly your manifold responsibility to your employer, your professional group, society and yourself. You pay more attention to what you should do than what you believe you should get.

- As a technical man, you must seek and maintain full competence in your chosen area of work. Realize that school knowledge decays in a few years, that productivity can be maintained or improved only by continuous effort. Avoiding technical obsolescence, you must also convert your abilities into accomplishment for your employer.

- Personal and professional integrity are assets of limitless value.

- Fulfilling your responsibility to your employer is the first mile of professional conduct. It's the second

mile, where you use your abilities beyond what's expected, that marks the true professional.

As a technical man, you alone determine whether yours is professional conduct. Speaking at the February meeting of AIChE, M. T. Carpenter went to the heart of the matter when he said, "No one has any sympathy for the technical man who claims he is not getting recognition; he simply wants people to feel how important he might have been if he had worked hard at it."

### Responsibilities of Employers

Since both employer and technical employee seek a common goal, they have concurrent responsibility to maintain highest standards of professional conduct. No sharp line can be drawn between the corporate responsibilities of managers and of technical personnel. The real responsibility of both is to the shareholders who "employ" them to maximize return on their invested funds.

Employees of process companies fall into three groups of nearly equal importance: operating personnel—with whom we are not here concerned—technical personnel and managers. The last two groups often overlap, and their professional standards are equally high. In each, the individual must have the initiative, perseverance and desire to grow. The company can provide the incentive, encouragement and environment. (It's preferable here to speak of company rather than management responsibility, even though for many purposes the two are identical.)

What are the tangible responsibilities of the company?

### Professional Opportunities

Although it's well known that sound, creative thinking is fostered by an environment that sets the stage for it, that environment can't be bought in any open market. Neither the technical man worthy of the name nor the company can survive without professional advancement.

Productive thinking is quickly stifled by intellectual isolationism. Where direction and information come only from supervisors, colleagues and in-plant experience, intellectual inbreeding inevitably results. No progressive company or wide-awake technical man can afford to ignore the burgeoning rate of technical developments, for to do so is to risk being left far behind. Since the company is a composite of all its employees, the broader the knowledge and ability of the individual engineer, the more valuable he is to the company. What's good for the technical man is good for the company.

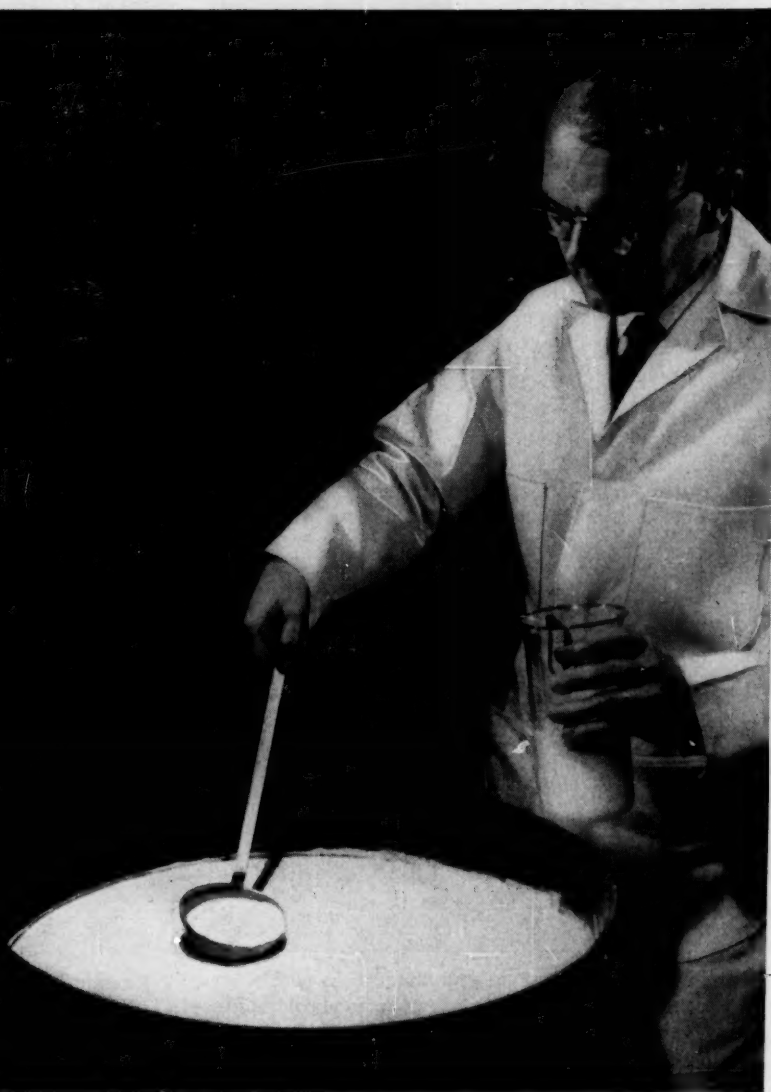
Some of the weapons to combat professional obsolescence are:

**Adequate Library Facilities**—Books and periodicals—some of a general nature—and the time to study them in conducive surroundings are prime requirements.

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*"As a professional, you recognize clearly your manifold responsibility to your employer, your professional group, society and yourself. You pay more attention to what you should do than what you believe you should get."*



be gained by group study in or out of company facilities.

**Publication**—Individual and company prestige are enhanced by publication of technical papers. Though no one advocates disclosure of proprietary information, clearance procedures shouldn't be so cumbersome that they stifle exchange or initiative.

**Professional Societies**—A remedy for the serious disease of professional isolationism or "hyperconfidentialism" is found in the professional societies. With little or no help from his firm, the technical man should be active in local-section affairs. If he is, the company should pay his way to at least one national meeting each year. Both the technical papers and the hallway bull sessions yield important information.

### Personal and Professional Recognition

Though it's essential that the company provide the opportunity to maintain professional competence, that is not its only responsibility. Recognition of accomplishment, both personal and financial, is nearly always incentive for further effort by the employed engineer.

Regardless of his specific job, the professional employee must make many choices that involve two or more alternatives. To do so, he must be able to see the problems clearly and without thought of his own personal gain. There's no disguising the fact that our society equates status with money, however. To get the creative, constructive thinking it must have, the progressive company must not have men who are worried about meeting basic financial needs or about not doing as well as their peers elsewhere.

In many companies, technical men can advance along two parallel routes—supervisory or technical. For full effectiveness, advancement along either route must be on the basis of individual merit, and it must be supported by a vigorous and continuously improving system of review.

In these days of increasing costs and of high demand for capable technical personnel, administration of equitable salary scales for professionals isn't simple. But neither is it easy for the engineer to maintain high technical competence and productivity. Unless its

men are professionally alert, no company can continue to meet competition. It's up to financial management to meet the problems surrounding the attraction and retention of competent technical personnel.

(The custom of giving scale salary increases to all technical personnel in connection with similar increases granted to others through labor-union negotiations isn't conducive to a high professional attitude. It may even be considered questionable professional conduct on the part of the company.)

### Money Isn't Everything

Personal recognition that enhances prestige, but doesn't encourage conceit, is essential to the high morale of both the technical man and his wife. And don't underestimate his wife.

Although some will question it, I feel that high morale leads to high productivity. Certainly the company that doesn't set and maintain high standards of professional conduct can't expect to retain either public good will or the respect and loyalty of its employees. The productive engineer, whose work is appropriately recognized, takes pride in his company when he feels the importance of his job and knows he contributes to successful management and operation.

No discussion of professional conduct is complete without consideration of the role of the technical society. One primary function of such a society is to establish and perpetuate standards of ethics for professional achievement. Too, such an organization seeks and encourages information exchange by sponsoring meetings, symposia and technical publications. Special awards and prizes of the society recognize outstanding accomplishment of its members.

Working together through Engineers' Council for Professional Development, the engineering societies support an accreditation program, which continuously examines undergraduate curricula. The American Chemical Society does the same for all curricula in chemistry. And special efforts are made by the societies to encourage professional development and to promote public recognition of the professional character of the engineer's work.

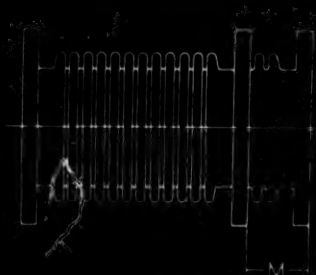
### What Is Professional Conduct?

It should be evident that the technical man can't sit back and wait for recognition to seek him. It may come, but if so, it won't be the kind he wants! The professional cannot isolate himself—unwilling to recognize responsibilities to himself, to his employer, to his community and his profession.

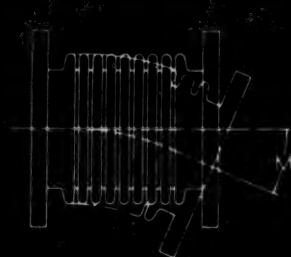
The company, on the other hand, also has much responsibility for professional conduct. It can't expect a continuing flow of high-level creative productivity without adequate personal and financial return. And it must adhere to the same levels of ethical conduct, behavior and loyalty to employees as it expects of them.

The path of professional conduct is hewn by the cooperative efforts of both engineer and employer.

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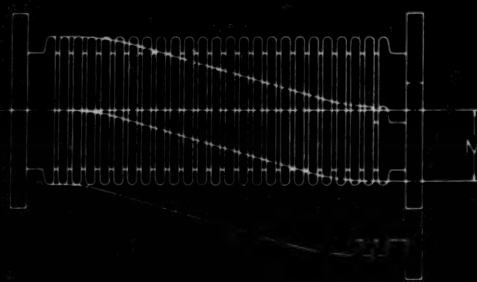
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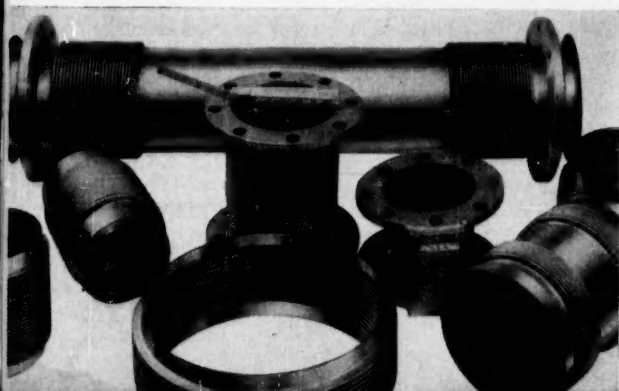
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*Simple, sensitive CS charts are finding new uses. They can help control not only process average but also process variation—the spread between individual results.*

W. CHARLES MAYHEW  
B. F. Goodrich Chemical Co.

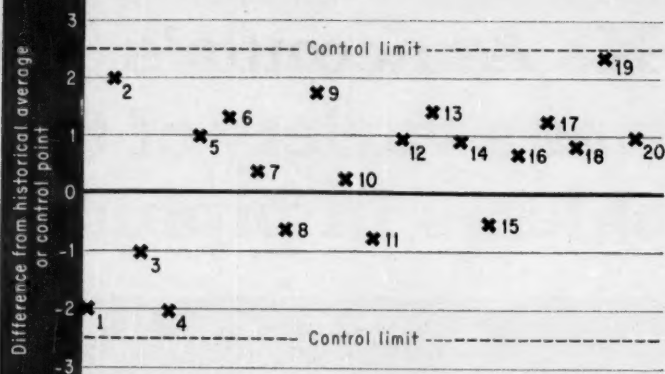


Fig. 1

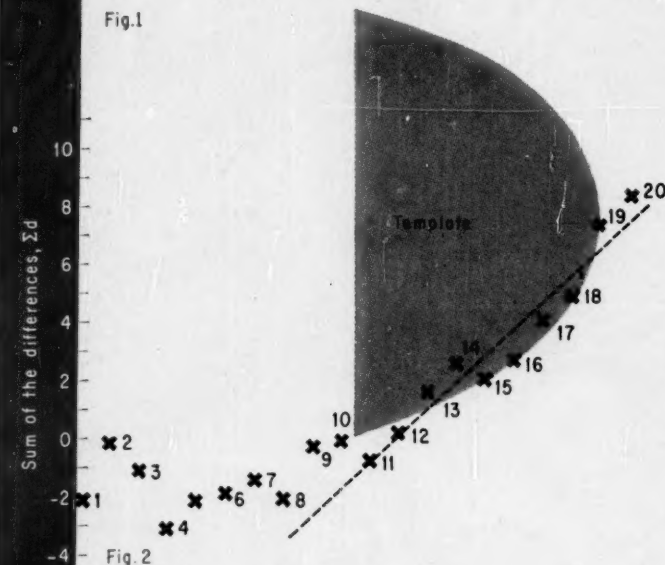


Fig. 2

## CS Charts Find Further Applications

During recent months, interest in cumulative-sum (CS) charts for process control has been growing rapidly.

A CS chart is essentially a running summation of difference between actual and expected results. It is simple to build and has these important advantages over conventional control charts:

- It is sensitive to even very subtle changes in the process. In situations where the process changes radically, CS charts are no better than other control tools, but where the change is slight but meaningful, the CS chart will detect this change much more readily.

- The layman can readily identify the suspect point at which the process changed.

- The CS chart may be more descriptive of how the process is behaving. By graphically screening out random variations, the actual systematic changes become more apparent.

Chemical firms can find innumerable applications for CS charts. For example, the charts can help detect changes in viscosity, particle size, temperature and pH. In some chemical processes, uniformity

of these characteristics is of critical importance, and here CS techniques may be particularly valuable.

So far, chief interest in these charts has been centered on their application to the control of a process average. However, a process may change in two basic ways: its average or its variation. Thus there is certainly a need for charts to detect changes in process variation—the spread between individual values—and we will show it is possible to use CS charts for just that purpose.

### How Do CS Charts Work?

Before we discuss process variation, let us briefly review how CS charts help control process average. Naturally, charts will not compensate for process changes, but will only detect them so that appropriate action can be taken.

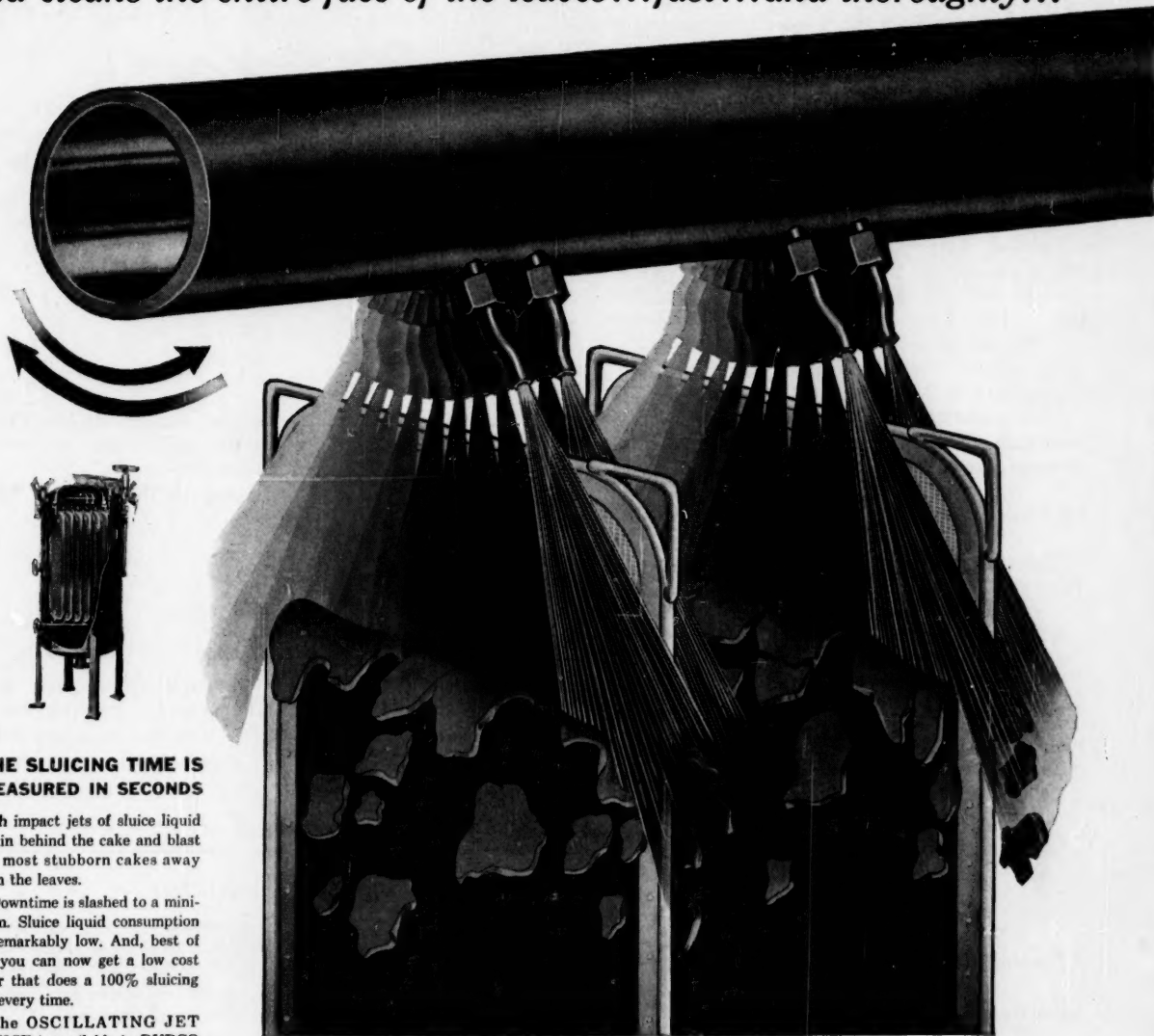
Let us suppose a quality characteristic has been averaging 50 ppm., and we want to know of any change in this average.

The CS chart for such an average will use the running sum of the differences between the individual

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results and the desired result of 50. Here are some sample calculations:

Individual Results,	Expected Results,	Difference,	Sum of Differences,
$X$	$\bar{X}$	$d$	$\Sigma d$
48	50	-2	-2
52	50	+2	0
49	50	-1	-1
48	50	-2	-3
51	50	+1	-2

If the individual differences are plotted on the usual  $X$ -chart (Fig. 1), the results look fairly random. It is hard to see whether the process has undergone a change unless many points fall outside the control limits. This, however, is not the case in our example.

If we plot the sum of the differences ( $\Sigma d$ ), the CS chart that results is shown in Fig. 2. As the ordinate axis on a CS chart is used only to plot points, it is the slope that is of interest, not the position of points relative to the ordinate axis. The sharper the slope, the bigger the variation from standard.

To help us detect significant changes in slope, we can calculate a template\* for the process.

If we place this template over the last plotted point, and if some previously plotted points fall outside the template, there has been a significant change.

Thus at  $X_{10}$ , we see that  $X_{11}$  and  $X_{12}$  are outside the template. To find out at what point the process average actually changed, we draw a straight line that approximates the series of points leading to  $X_{10}$ . We can conclude that the change occurred where this straight line no longer fits the points—in other words between  $X_{10}$  and  $X_{11}$ .

This is one of the advantages of the CS chart—the ease with which a layman can identify the shift point, so as to take corrective action.

### CS Charts for Control of Variation

Three varieties of CS charts may be considered for control of variation.

- Absolute deviation.
- Range.
- Successive difference.

The first of these is based on the absolute deviation, and is calculated as follows:

Individual Result	Expected Result	Absolute Deviation	Expected Deviation	Difference	Running Sum
$X$	$\bar{X}$	$d$	$E(d)$	$d - E(d)$	$\Sigma$
56	50	6	2	+4	+4
48	50	2	2	0	+4
51	50	1	2	-1	+3
47	50	3	2	+1	+4
52	50	2	2	0	+4

\* The template in the example was calculated using the formula

$$H_n = z \times \sigma \times \sqrt{N}$$

where  $H_n$  is the height of the template at point "n."

$N$  is the number of points from the tip of the template.

$\sigma$  is the standard deviation of the plotted points.

$z$  is the deviation from the mean in number of standard deviations of an average that has undergone a change just large enough to be considered significant.

The running sum is then plotted on the CS chart.

This chart is the most sensitive to a change in the process variation. However, it is dependent on the process average; and hence, if the average changes, so will this running sum. Therefore, in processes where the average is likely to change more than the spread (or variation), this absolute-deviation CS chart may not be the best choice.

The CS chart based on the range between pairs of results will overcome part of this dependence on the average, but will lose some sensitivity. The running sum for the CS chart that is based on this range is calculated as follows:

Individual Result	Range of 2	Expected Range of 2	Difference $d$	Running Sum $\Sigma d$
$X$				
56				
48	8	3	+5	+5
51				
47	4	3	+1	+6
52				
50	2	3	-1	+5

The third type of CS chart for variation is based on successive differences. The running sum for this chart would be calculated as follows:

Individual Results	Successive Difference	Expected Difference	Difference	Running Sum
$X$	$d_s$	$E(d_s)$	$d_s - E(d_s)$	$\Sigma$
48	8	3	+5	+5
51	3	3	0	+5
47	4	3	+1	+6
52	5	3	+2	+8
50	2	3	-1	+7

In regard to sensitivity and dependence on the process average, this chart lies somewhere between the other two CS process variation charts.

We can summarize and compare these charts as follows:

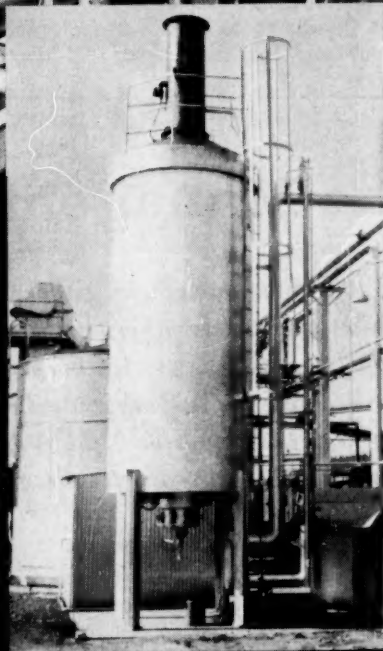
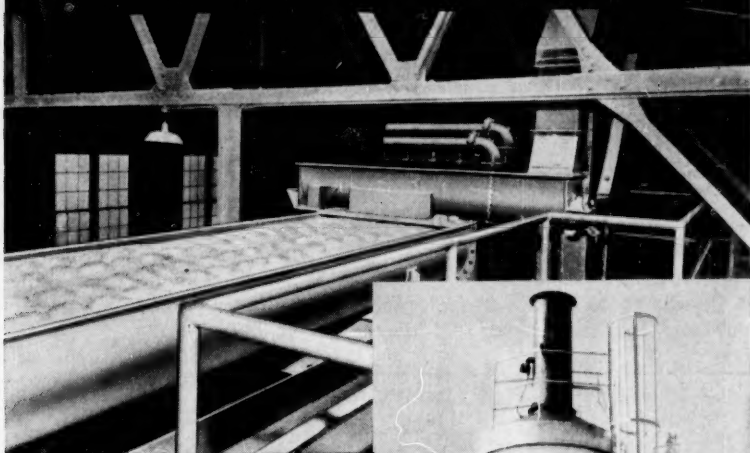
	Sensitivity	Dependence on Average
Absolute deviation.....	Excellent	Fair—Poor
Range.....	Fair	Good
Successive difference.....	Good	Good—Fair

Hence, in a process where variation is likely to change much more than the average, the absolute-deviation chart can be used. However, in a process where the average may change somewhat less con-

### Meet the Author

W. CHARLES MAYHEW is a graduate of Pennsylvania State University, with B.S. and M.S. degrees in industrial engineering. He joined the B. F. Goodrich Co. in 1954, and is now statistician in the product improvement group at Goodrich Chemicals' headquarters in Cleveland.

He is a member of Operations Research Society of America, Institute of Management Sciences and American Statistical Assn.



\*

**\*WESTERN  
PRECIPITATION**

siderably, the chart based on range may be best suited for controlling variation, even though it is less sensitive.

The successive-difference chart may be a good compromise if changes in process average are likely to be small but not insignificant.

The use of CS charts to control variation should greatly extend their applications—in fact they can

be used wherever Shewhart X-charts and R-charts\* are used.

It is significant that while practical application of the cumulative-sum technique in this country goes back not much more than a year, it has already established itself as representing a significant advance in statistical quality control.

\* Koehler, T. L., *Chem. Eng.*, Dec. 12, 1960, p. 143.

## Make Management Training Count

*If you work in a managerial capacity, you should help teach others to manage. Don't let outside agencies or plant training directors do all the work—you may be the only one who can weld the training program to the job.*

ROBERT P. BOTT, *Dow Corning Corp.*

Are you a manager interested in developing management skills in your present and potential supervisors?

If you want them to have a training program that is really effective—one that is not just an academic or social exercise to enhance your company's progressive image—then get in there and help in the training. You may be the best, and often the only, person who can really link the program to the actual needs of your men.

By the way, if you yourself are a supervisor or foreman, what follows should give you ideas on how to get the most out of a supervisory development course.

### The Boom in Training Programs

The job of a supervisor in today's modern industry is complex. It's so challenging that when our companies look for a supervisory replacement, it's often difficult to find and select the right man for the job. And as we move up the managerial hierarchy, the number of qualified men becomes smaller and smaller. As a result, training programs of all kinds have increased rapidly.

Each day, three to five pieces of literature sent by colleges, correspondence schools, consultants and professional organizations cross my desk at Dow Corning. And industry has not been sitting idly by. We, too, have been actively engaged in the training business. Last year, the American Society of Training Directors

listed over 3,600 members—a jump from 700 in the last four years. Most of these men are doing in-plant supervisory training. In addition, the American Management Assn. annually trains over 100,000 executives in its conferences, courses and clinics.

Now, what's this training all about? It really has one purpose—to get out more work. This is fundamentally the job of any management man, no matter where you find him in the organization. To do this, the real manager depends on knowing and applying the basic principles of management. These are: Organization—Staffing—Planning—Direction—Control. These management principles are taken up in course after course offered by outside training organizations.

Well, then, let's send the boys to such courses. Yes, that could certainly be part of the answer—but such college, AMA or conference training programs should be used to supplement sound in-plant programs rather than to substitute for them.

### Learning Is Not Enough

The key to successful management is not just learning management principles—it's the learning and application of them.

It's like knowing a wonderful recipe for pumpkin pie, just another recipe, a group of words until you put them to work. When you pour and mix the ingredients, add a little nutmeg, and finally take your concoction from the oven, you have a pumpkin pie. The real test is when your family consumes it and says, "Gosh Dad, you can really cook, too."

I've always been somewhat skeptical of training where the supervisor is sent to "Eager Beaver Island" and inoculated with managerial religion. Too often, he returns to the mission field and has difficulty selling his new religion. He has learned a new language that the rest of the tribe can't understand. They listen to what the Great White Father has to say, but the follow-through—well, it just doesn't happen.

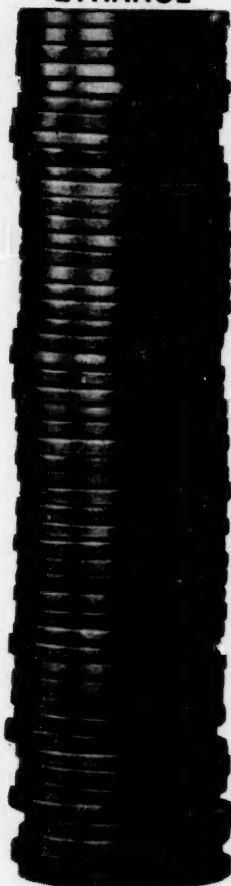
### Help Train Your Supervisors

What I recommend is the teaching of management principles within industry—in your department by

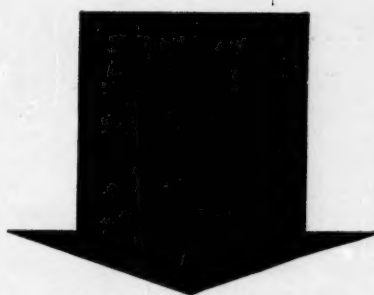
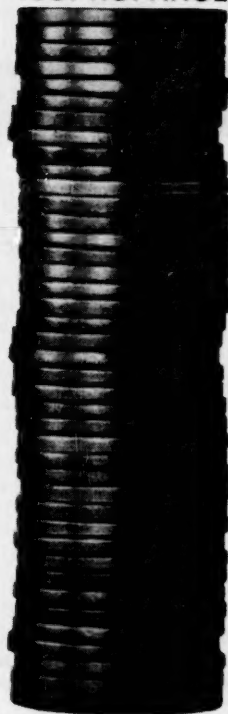
Some of the thoughts in this article were included in an address "Teaching Supervisors the Principles of Management," given by the author at the 12th Plant Maintenance & Engineering Show, Chicago, Jan. 23-26, 1961.



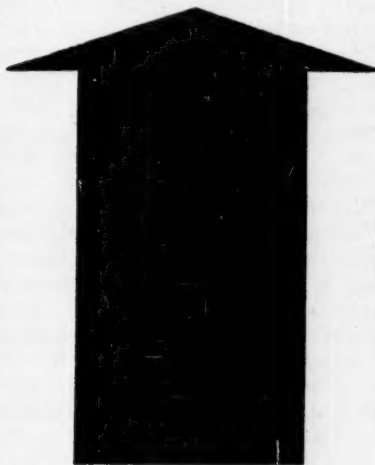
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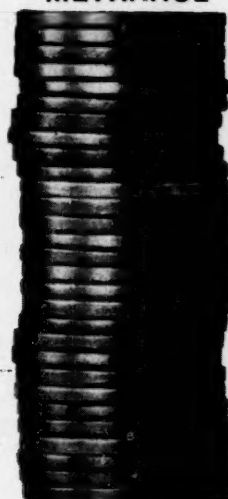
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you. This is a welding together of the training process and the job. It can be accomplished in any company simply by following the principles of management when you organize your training. To make it a little more realistic, let's explore the subject by training one of your supervisors.

Take Torque Wrenchwell. He joined your repair department in 1948. He was young, smart, energetic and hard working. By diligent pursuit of the Journeyman Training Program, he advanced through the various progression steps and by 1953 was a full-fledged Journeyman Mechanic. He was the type of man you like to have on your crew—accepting whatever job was given to him without complaint and doing more than his fair share of the work. In the event of an emergency breakdown, day or night, Torque Wrenchwell could be depended upon to do a job in a minimum length of time.

He was one of the natural choices when it came time to add another foreman to handle your expanded crew. So, after suitable screening procedures, Torque was selected to become a part of management. He ran the afternoon crew of ten men, taking care of emergency work and jobs of high priority. It was said, let a pump or compressor break down and Torque would not only bring the crew in the trunk of the plant car, he carried half of the spare parts needed—the other half were under the front seat.

Now, it's today, and an opening has just come up for a manager of one of your repair groups. Because of the rapid growth of your plant and the need for increasing maintenance facilities, Torque, although he is young, has been selected to do the job.

You give Torque some orientation and place him in charge of the repair shop. One day, you drop in to see how he's doing. What do you find? The shop is half full of pumps and parts. The crew is confused. A production superintendent is screaming because he can't get his equipment in operation, and the power engineer is all steamed up because his commutators are sparking and no one is doing anything about it. In the midst of all this, Torque is rushing around, single-handedly trying to cope with this mad maze of problems. A good man who has been moved to management but doesn't know what to do.

Is this somewhat exaggerated instance an unusual situation? I think not. Torque has never had to manage before—so what should we expect? Let's see if we can help him by following the principles of management ourselves, setting up our program to help people like Torque.

### Principle I: Organization

Whether you plan to teach a course or program yourself or with the help of others, organize it so the training and its philosophy will become a part of the life blood of your organization. In other words, if you're going to teach delegation to Torque and others, after a discussion of what is meant by "delegation,"

you should work on applying the principle. Consider the problems as a part of the job or course. How are we delegating? What can we do to improve? Bring the issues right to your own backyard.

Keep your higher managers cut in on the game. A newly-trained supervisory force becomes frustrated and hypercritical of management unless the latter also practices sound managerial principles. If your superior is unable to attend training sessions, keep him so well-informed that he will feel a part of them.

How about your men? Are they so busy that they find it difficult to attend a training session? If you can't hold your meetings during working hours, begin after work and buy Torque and his cohorts a meal. For the past two winters, we have conducted 4:30-8:30 p.m. training meetings with excellent attendance.

### Principle II: Staffing

A manager who attempts to do all his training by himself is losing the services of one of his best friends, the educational specialist. I'm not saying, give him the job to do and forget him. What I advocate is working with him. Get some mileage from him. He knows where training materials are. He can come up with courses and materials and ideas, so that you can design and plan your program to fit your needs.

No one learns like the teacher, therefore one of the best ways to bring about a change in attitude or methods in a supervisor is to assign him the job of teaching a course or a phase of it. Let's give Torque the problem of improving the flow of materials and equipment. In his assignment, make sure that he has access to people and source materials so he can come up with some concrete answers. Work with him, coach him.

When Torque presents the session or helps in its presentation, you will have an advocate of the ideas presented. What is even more important, the odds are in favor of Torque utilizing the ideas when he returns to the job. He may even improve your present method of getting materials from stock to your field men.

### Principle III: Planning

In looking at the planning phase of how to train supervisors in management principles, two major suggestions are:

Plan a program that has a professional touch. Nothing falls flatter than just a lecture presentation, or is less convincing. Adults in industry are not motivated in the same way as college freshmen. They have to be taught with charts and graphs, slides and transparencies, not only because these increase retention, but more important, it shows you that you care enough to give the very best. In short, you have planned.

Ask your training man for case studies and arbitra-

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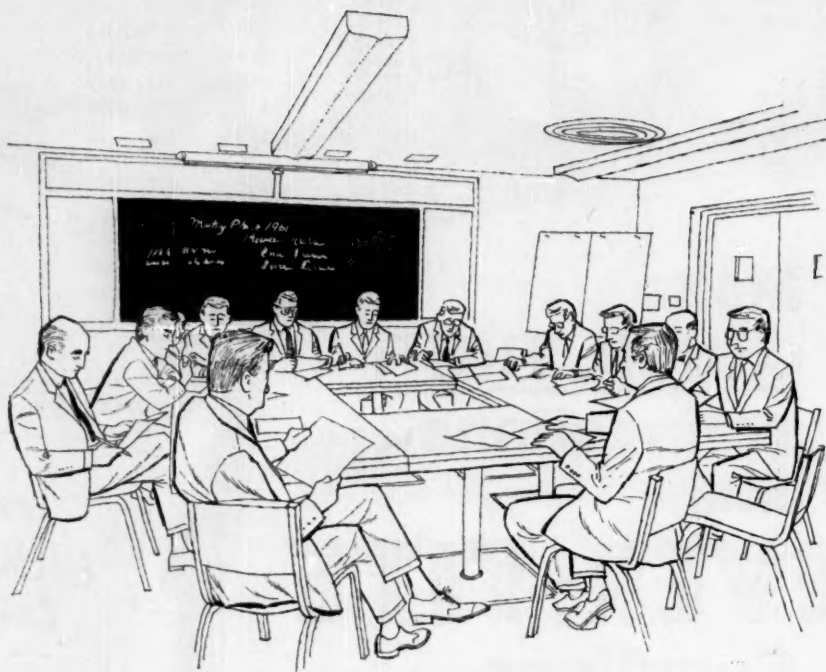
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couplings  
it calls for  
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*Supervisors at Dow Corning act as a steering committee for their supervisory development program. They help select meeting topics, review all meetings prior to presentation to the rest of the supervisors and assist the meeting leaders.*



tion decisions based on situations and experiences that tie in directly with your activities. It doesn't take much imagination to alter training materials to fit. Your people will appreciate it and once more they'll get the point. For example: in a case study, is it more valuable for Torque to learn how to reorganize a department store that's failing, or improve the flow of job orders between production, design engineering and the shop in a hypothetical company?

Another interesting aid in managerial training is the use of the "In-Basket Technique." Here you present a group of problems in the form of written notes or letters. Each manager finds these in his in-basket and must act upon them in a limited time, say 15 minutes. Each decision is then compared and discussed with the group. Everyone from our assistant production manager to our first-line foreman have frankly discussed many problems introduced in this manner that were sidestepped when presented in a regular discussion.

Learning from problems of this nature is fine, but the key is practical, on-the-job application. For example, after you have introduced the principles of work load charts and scheduling of labor and material, ask Torque and each of the other supervisors for their toughest planning problem, or the one they experience most often. Then, as a part of the program, have them come up with alternate proposals to overcome each of them.

If you have a work improvement program, have each supervisor turn in a job to be improved. If you are discussing staffing, have each superintendent turn in a program he would use, in order to staff two open-

ings should two of his foremen be transferred. Have the superintendents include the factors they would use to judge by—the tests they would consider giving and the records they would develop to help themselves and those in the company who could assist them in their final choice. If they feel weak on testing or selection methods, you have two or three ready-made meetings that should be presented.

Tying it back to the job takes theory out of the realm of fantasy. When Torque, as a part of the program, brings a problem to be solved back to his job with him, you get action. He gets an opportunity to sell the ideas to himself. You don't do it. This is important, for we adults unconsciously resist change. When we test the ideas ourselves, however, we overcome our own resistance.

#### Principle IV: Direction

I believe one excellent way to handle the elusive matter of direction is by combining autocratic leadership, democratic leadership and the self-motivation approach.

There are times when each type of leadership will work the best. For example, we know of one supervisor in our plant who worked diligently to come up with a deer hunting schedule that all the shift men in his production unit would like. His attempts were noteworthy but, although he was an excellent salesman, the men just wouldn't buy. Finally, he called them in, discussed the problem and asked for their



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answer. After a couple of days, one of the workers dropped a written answer on his desk, signed by the entire crew. Their decision is still in effect although it was made some ten years ago.

This method—democratic leadership—is one of the ways to give direction to your program. Let your supervisors democratically pick the subjects for discussion themselves. If Torque is genuinely interested in how to better budget his time and asks for guidance, he will probably apply some of the suggestions that he receives to his own job.

As for autocratic leadership, you, as a department manager, may have a definite idea of some type of training that should be done. It may be in the area of discipline, budgeting, or cost control. Because of your position, you can probably best judge the need for it. If that is so, introduce it. Does this make you an autocratic supervisor? No—just a good business man. You could wait all year and your men would probably never ask for training in these areas. It's up to you to suggest and perhaps even develop and present it.

Your training specialist may also have ideas that should be integrated. Talk to him about them.

How about individual or employee leadership? Actually, some supervisors who are strong individualists may resist both autocratic and democratic leadership. The direction and guidance offered to them may have to be different and require your personal touch. Here, the individual leadership approach may pay off, if we think of it as encouraging these individualists to find the motivation for progress from within themselves.

We in education have had the opportunity to experiment with various types of leadership when conducting simulation training. One fact is quite obvious: no one type of leadership is most effective. It's a combination of the various types that works best.

Thus, we suggest you use autocratic and democratic leadership in choosing topics, with a personal touch for those men who tend to resist any kind of leadership. There is no better way to get action than this.

### Principle V: Control

We at Dow Corning measure reaction at the end of every training session to help us control our effectiveness. This is done by passing out a slip of paper containing these two questions:

What do you think of the meeting? (Check one):

No Good	Mediocre	All Right	Good	Excellent
Why?				

This simple device gives us a running record of what our supervisors think of the material they are receiving. In addition, it acts as a terrific stimulus to the speaker or conference leader. He wants to do his best—after all, who likes a low rating?

Another control we utilize in our training is an

outgrowth of being connected with the chemical industry. It's the utilization of pilot-plant runs. After we have a meeting prepared for our supervisors, whether it was organized by in-plant training experts or some of the participants, a representative group listens to the topic or "sits in" on a trial run of the meeting. At the end of the pilot run, we discuss these two questions:

- Do you think this subject as prepared should be presented or discussed with our supervisors?

- What changes do you suggest?

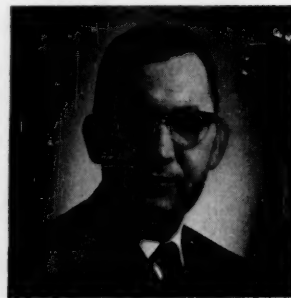
After following this format for the past eight years, we can honestly say that these two simple devices have provided good control. If your class is too small to use the latter technique, a discussion with a representative trainee in which you outline your plans for the session may suggest changes to you.

As another control tool, we measure supervisory attitude at the beginning and end of our training program. Experience has taught us to anticipate positive attitude changes, and we are seldom disappointed.

Needless to say, none of these devices are foolproof, they are only indicators. But because they are not perfect doesn't mean they should be left on the shelf.

Follow-up is perhaps the most significant control device. For example, Torque may have found that work measurement techniques make an interesting training topic, but unless he uses the system to better measure work, you have sown your seeds in vain. If this is the case, a little individualized coaching may pay rich dividends. If you have succeeded in linking the training program to the job, as we have discussed, all that may be needed is advice on how to surmount unforeseen difficulties.

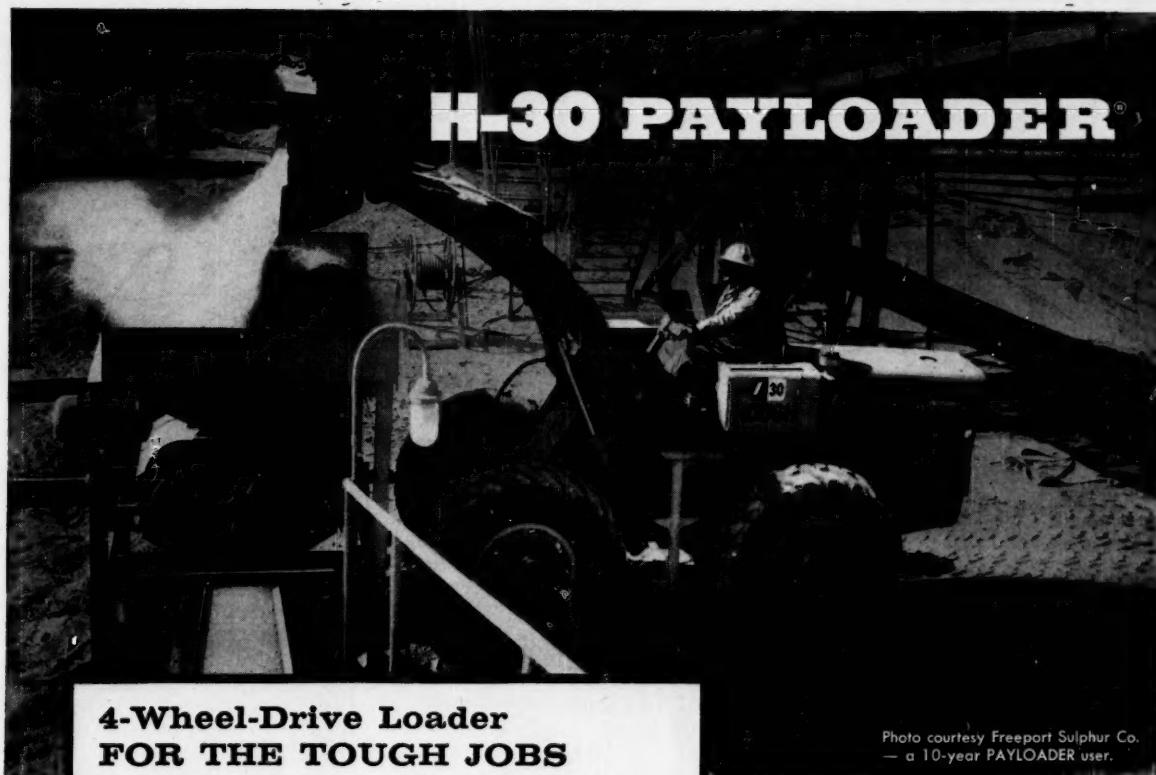
Meet  
the  
Author



ROBERT P. BOTT is the director of education and development at Dow Corning Corp. in Midland, Mich. He joined the company in 1948.

In his work, Mr. Bott coordinates numerous training activities including programs for senior, general and new supervisors, and other professional employees. He also directs the company's adult education activities and apprentice training.

A Navy officer during World War II and the Korean conflict, he holds an M.A. degree in education, with specialization in personnel and guidance.



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6-8-3

## Reinforced Plastics for Corrosive Service—I

*A guide to the design of equipment for the CPI. This article covers the applications and advantages of plastics. Part II will discuss selection of resin types.*

ROBERT M. WEBSTER, E. I. du Pont de Nemours & Co.

Use of reinforced plastics in processing and other plant equipment, especially in corrosive service, offers the chemical industry one of the newest, most promising ways to achieve manufacturing economies. In a properly designed piece of equipment, these materials can contribute to important savings in capital expenditure and maintenance costs. The necessity for these savings is emphasized today by the difficulties plaguing the chemical manufacturer: rising manufacturing costs, keen domestic competition and an increasing tide of low-priced imports.

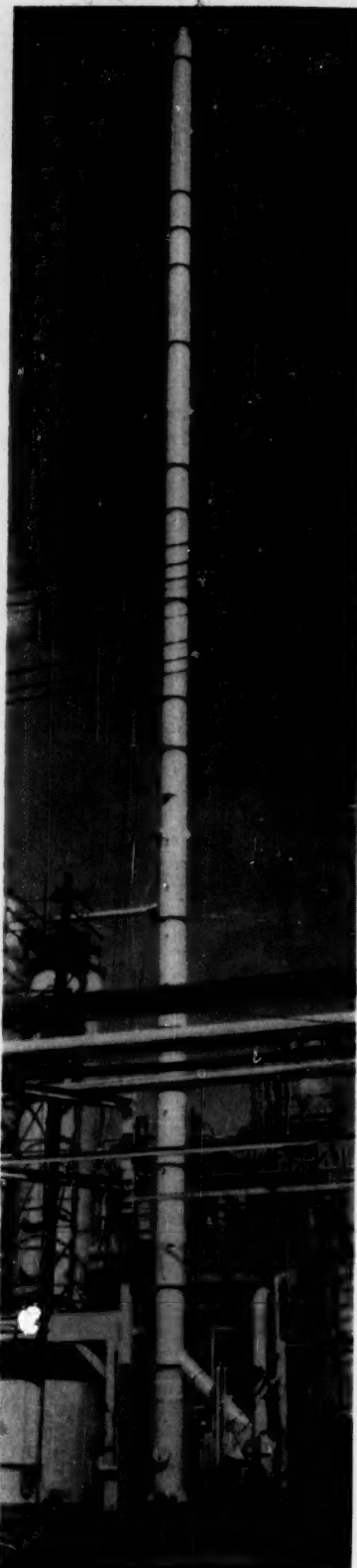
When properly employed for specific applications, today's reinforced plastics can no longer be considered experimental or substitute materials. They are being accepted on the same basis as the stainless steels and other metal alloys, for the construction and repair of chemical manufacturing equipment in corrosive service. Design know-how, achieved through an ever-increasing amount of field experience, is now sufficient to enable use of these materials with a reasonable degree of confidence.

Potential applications for reinforced-plastic equipment in the chemical industry are vast. There still remains, however, a great need for development, field-data gathering, education and standardization, before this potential can be realized. For example, improvements and standardization in compounding, curing and testing are

vital to progress in the field. Those designing and specifying chemical equipment need clear and accurate up-to-date technical data on reinforced plastics. Many users, for example, will specify "glass-reinforced polyester," without realizing that the term polyester refers to a whole family of resins, each with its own special properties and proper applications.

To reap the maximum benefit from reinforced-plastic equipment, the user must understand and recognize the many variables that influence results: type of resin, filler, reinforcing fiber, resin-fiber ratio, schedule of laminating, design details, and testing specifications.

► **Properties and Advantages**—Reinforced plastics offer a cost advantage over most other materials for the construction of high-strength equipment that is resistant to a wide range of corrosive environments (see p. 158). Savings over stainless steel and lined constructions for the typical classes of equipment cited range from 15% to 80%. The nature of the lay-up molding technique allows fabrication in extremely complex shapes without excessive cost. In general, these plastics have a versatility of chemical resistance superior to metals and alloys (see p. 156). Although plastics are free from some of the weaknesses of metals, such as atmospheric corrosion and galvanic action, they do have temperature limitations in the



Polyester stack, fiber glass reinforced, furan lined, 30-in. dia., 160 ft. high.



## *Corrosion from hot acid mixtures?*

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## Purchase price comparison factors for uninstalled process equipment

	Carbon Steel	Reinforced Plastic	Reinforced-Plastic-Lined Steel	Elastomer-Lined Steel	Lead-Lined Steel	Brick-Lined Steel		Stainless Type 304	Hastelloy C
						Single	Double		
Process tank, 1,000 gal. ....	1.9	1.2	2.4	3.7	3.8	4.5	6.0	6.0	....
Process tank, 5,000 gal. ....	4.2	5.6	6.1	8.2	8.5	10.5	14.5	12.3	....
Storage tank, 5,000 gal. ....	4.8	6.7	7.1	10.6	11.0	....	....	15.3	....
Rotary vacuum filter, 18 sq. ft. filter area *	....	7.1	....	12.8	....	....	....	....	21.5
Centrifugal ventilation fan, 49" wheel, 15,000 scfm @ 5" static press. †	....	2.5	....	2.9	....	....	....	....	....
Vapor duct, 4" dia. ....	4.2	3.5	7.2	12.0	9.2	....	....	7.0	....
Vapor duct, 12" dia. ....	12.6	6.3	20.0	34.0	27.0	....	....	21.0	....

\* Complete with drive and motor.

† Without motor.

general range of 200 to 500 F. under continuous operating conditions.

Reinforced thermosetting plastics have good dimensional stability, are light in weight, and have excellent dielectric properties. Since they are low-density materials, with a low degree of heat transfer, insulation of equipment can be minimized or eliminated. Dyes or pigments mixed with the precured resin will color the equipment permanently and minimize the need for costly periodic painting.

The relative lightness of reinforced-plastic equipment reduces handling problems and cost during installation. The equipment can be cut into segments and erected in

place, to eliminate the removal and reinstallation of other processing equipment or housing walls. This possibility offers great advantages when the construction area is congested with manufacturing equipment. Field joining is simple and, when well-executed, will provide physical properties in excess of the individual structural members. The joints are made without open flames or sparking tools, so there is no need for interruption when the manufacturing operations involve flammable materials.

► **Applications**—The applications of reinforced plastics in the chemical industry can be divided into three general categories:

• Equipment fabricated com-

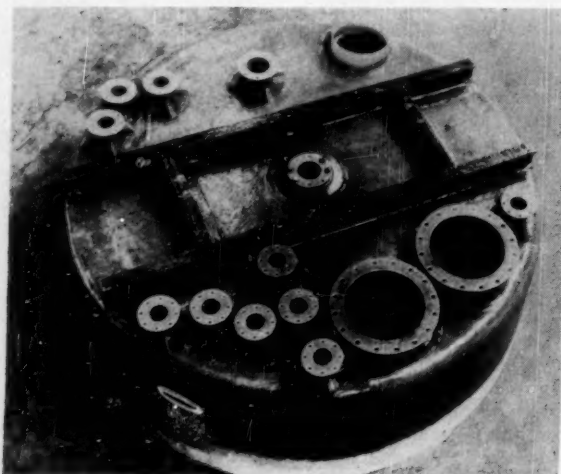
pletely out of reinforced plastics.

• Plastic-lined or coated equipment, which relies on another material for structural support but depends on the bonded reinforced-plastic coat for protection against corrosion.

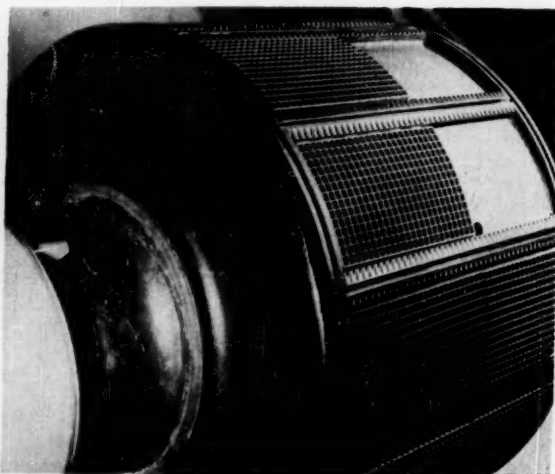
• Repairs made by adhesive patching or wrapping a damaged section with reinforced plastic.

Recently, there has been a rapid growth in the use of reinforced-plastic fume removal (hoods, ducts, fans, stacks, scrubbers, etc.) and processing equipment (tanks, pipes, etc.). Reinforced tanks up to 12 ft. dia. x 12 ft. deep and piping systems up to 1½ ft. in dia. are common.

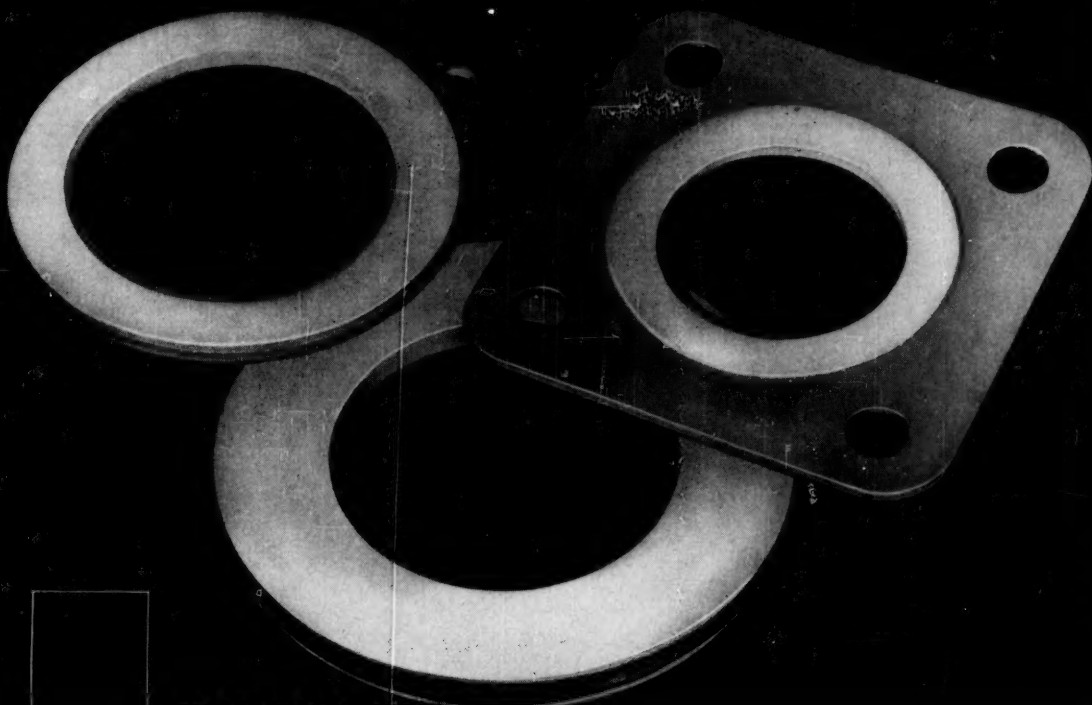
Reinforced-plastic liners can be



Process tank, bisphenol A polyester, fiber glass reinforced.



Plastic drum of continuous rotary vacuum filter.



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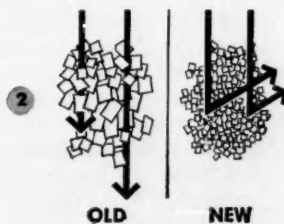
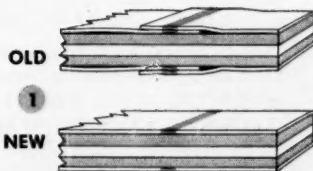


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# GARLOCK

[illegible]

Chemical resistance (relative) of various plastics. Concentration of corrodent is indicated by shading, i. e., shading of first quarter of box indicates resistance to concentrations up to about 25%.

used in equipment where process pressures exceed practical limits of a total reinforced-plastic system. Here, an inexpensive mild steel structural member is lined with a protective chemical-resistant plastic. This type of lining generally costs substantially less than brick, lead or rubber.

Linings are also recommended for existing equipment where failure is imminent or when a local area, such as a welded seam, has developed a leak. When the basic structure is adequate, a reinforced-plastic lining will greatly extend the service life of the unit. In addition, where the structural integrity of an original low-pressure unit is questionable, a reinforced-plastic external wrapping can be designed to furnish the required structural strength. The worn or damaged equipment serves only as the mold.

This technique is especially useful for replacing deteriorated vapor lines. Wash-out ports and clean-out traps are incorporated for removing the old equipment as it disintegrates. This type of restoration can be made at low cost, and without interruption to manufacturing cycles. In effect, the end result is a 100% reinforced-plastic

duct, inexpensively fabricated in place.

A leak in large metallic piping systems and process vessels can be quickly repaired without open flame, arc welding or extensive decontaminating by applying a temporary external reinforced-plastic patch. This type of temporary repair minimizes or eliminates interruption of the manufacturing process and permits a planned shutdown for permanent repair or equipment replacement.

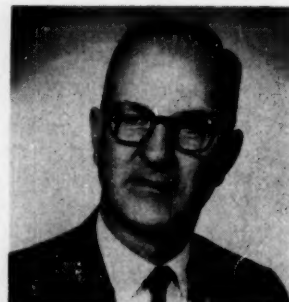
► **Selection of Materials**—The materials comprising the reinforced-plastic laminate will spell the difference between long uninterrupted service life or premature failure of the equipment. It is essential, therefore to select all materials on the basis of the specific application. No "universal" material exists.

Selection of materials should be based on an adequate testing program. Calculated or estimated data are usually insufficient for designing a sound structure that will perform satisfactorily in a corrosive environment. Selective testing should be conducted by a person with a basic knowledge of resins, reinforcing materials and reinforced-plastic design.

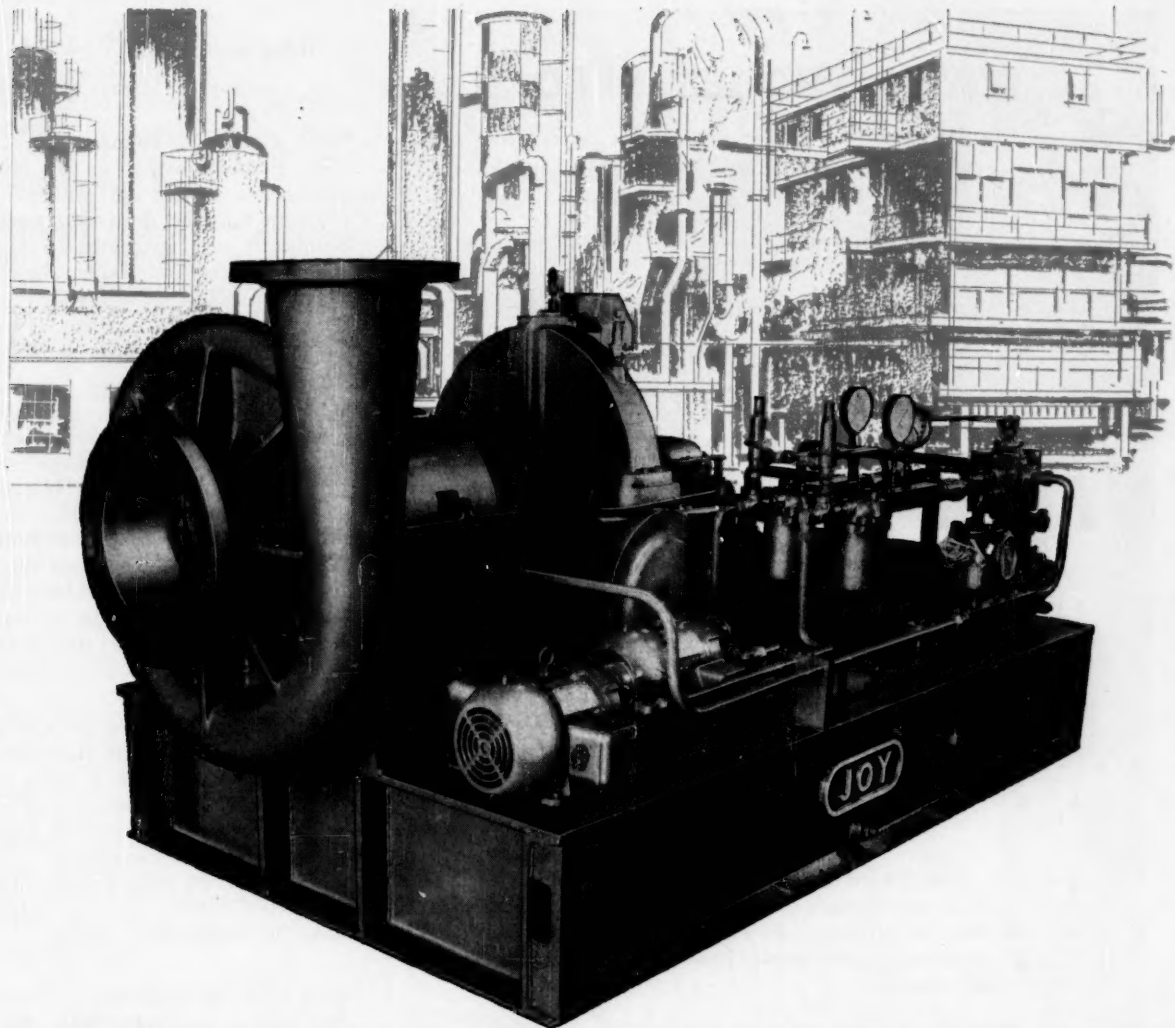
## ACKNOWLEDGMENTS

The author gratefully acknowledges assistance given by H. E. Atkinson, Du Pont Engineering Dept., and W. D. Lynch, Du Pont Organic Chemicals Dept., for development of comparative corrosion data; also to W. T. Weir, Du Pont Organic Chemicals Dept., for development of price comparison factors.

## Meet the Author



**ROBERT M. WEBSTER**, is a consulting and design engineer for process equipment and nonmetallic materials of construction at Du Pont's Chambers Works plant at Deepwater, N. J., where he has worked since 1939.



## JOY MODEL "G" SINGLE-STAGE CENTRIFUGAL COMPRESSORS PROVIDE THE UTMOST IN RELIABILITY

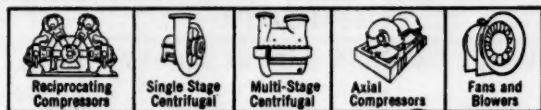
Joy Model G Single-Stage Centrifugal Compressors are designed and built to service continuous processes with the utmost reliability. They have a minimum number of bearings and no high speed couplings. Impellers are machined from a single piece of metal, and the entire compressor is ruggedly built.

Model G Compressors are not only reliable and maintenance-free, they also are highly efficient and very compact. They take less than half the space occupied by units of comparable output. Good aerodynamic design permits a reduction in scroll size,

and use of an integral gear further reduces size and weight of the unit. Compressor and drive are mounted on a single base plate.

Model G Compressors are available in 6 models with capacities from 500 to 15,000 cfm—at 3 to 20 psig. on air service. For handling gases, special construction, materials and seals can be provided. Joy can also furnish reciprocating, multi-stage centrifugal and axial flow compressors to handle any air or gas compression requirement of the chemical processing industry. For full information on the Joy Model G Centrifugals, write for Bulletin 2468-11.

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### CPI NEWS BRIEFS . . .

*Continued from page 74*

facilities in Tonawanda, N. Y. Plan includes construction of a 60,000-sq. ft. factory in which to fabricate the type of air-separation equipment that goes into Linde's on-site liquefied-gas plants; hence, expansion reflects the firm's budding business in cryogenics. Program is scheduled for completion about a year from now.

**Suntide Refining Co.**, a subsidiary of Sunray Mid-Continent Oil Co., has begun producing 750 bbl./day of benzene from a \$1-million Hydeal unit at its Corpus Christi, Tex., refinery. Toluene from a Platformer is separated by a Udex unit, then hydrodealkylated by Hydeal with hydrogen from the Platformer.

**Air Reduction Chemical & Carbide Co.**, a division of Air Reduction Co., Inc., has placed a \$300,000 vinyls plant on stream in City of Industry, Calif. Output is Flexbond copolymer emulsions and Vinac polyvinyl acetate resins and emulsions, but no capacity figures have been released.

**Gulf Oil Corp.** made news twice in two days at its Philadelphia refinery: on May 16, the company placed on stream its multimillion-dollar oxo alcohol plant, described as the largest ever built (though exact capacity figures haven't been released); on May 18, ground was broken for a 100-million-lb./yr. cumene plant, construction of which will cost "millions." A companion benzene unit will be built to feed the cumene installation, due on stream early next year. Part of the complex' existing capacity for propylene will be rerouted to the new petrochemical facility.

**Ford Motor Co.** has completed a major expansion of its Nashville, Tenn., glass works (already said to be the world's largest), incidentally becoming the nation's only auto manufacturer to make all its own glass. Henry Ford II, opening the revamped 1,100-ton/day plant, noted that the company had in-

vested "tens of millions" in the installation to date. Facility gulps in 400,000 tons of sand, 25,000 tons of limestone a year.

**National Lead Co.** has broken ground for a multimillion-dollar research center on a 250-acre site near Hightstown, N. J. Scheduled for completion next summer, facility will be the heavily research-oriented firm's seventeenth laboratory (the company put research on the payroll in 1891, one of the earliest known dates for such a move).

**Hoffman Electronics Corp.**, Los Angeles, has a \$185,000 Navy contract to fabricate the solar batteries for an upcoming family of Transit navigational satellites. Hoffman's silicon solar-energy cells in Vanguard I are still in orbit after three years, converting sunbeams directly into electricity.

**Linde Co.** has opened a flame-coatings plant at North Haven, Conn., adjacent to the firm's oxygen/acetylene facility. New 11,000-sq. ft. factory complements similar facilities in Indianapolis and Los Angeles.

**Kaiser Aluminum and Chemical Corp.** has announced the reopening of two more potlines at its Mead, Wash., aluminum works, bringing to six (out of eight) the number of lines now operating at the site. Since April, Kaiser has reactivated a total of seven lines in Washington, Louisiana, and West Virginia (*Chem. Eng.*, May 29, p. 123).

## Offices

**Western Petrochemical Corp.**, New York, has moved its headquarters to Kansas City, Mo. Firm makes waxes at Chanute, Kan., in a refinery said to be the largest of its kind, and plastics at Newark, N. J.

**California Chemical Co.'s** Ortho Div. has consolidated its Mid-

# THE Anatomy OF A ROTAMETER

This is a rotameter skeleton. But it's an exo-skeleton like nature gave the lobster. And like the lobster's, it must be strong and rigid — powerful protection for what's inside.

That's why the frame of Wallace & Tiernan's new Varea-meter is one rigid piece. No bolts or pins hold parts together. Stainless steel shrugs off corrosion. Deep-formed construction resists pipe strain, protects tube alignment. You have less maintenance; life-long, positive metering accuracy.

Other Varea-meter extras: Fewer parts overall, end fittings that rotate through 360°, and a tube-locking clamp that's easily controlled yet so powerful it ends the unseating of tubes.

Varea-meters come in  $\frac{3}{8}$ " through 3" sizes with 5" and 10" scales. They meter up to 310 gpm water or 1300 scfm air over a range of at least 10 to 1.

For more information,  
Write  
Dept. V-7.29

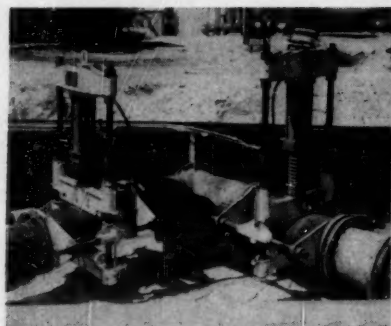


**WALLACE & TIERNAN INC.**  
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

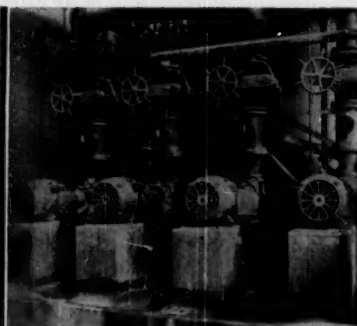
# Virginia-Carolina Chemical Corp. Selects Massco-Grigsby Pinch Valves for New Phosphate Plant

**200 Valves—sizes from 3" to 10"—  
types from handwheel to automatic operation.**

Based on its previous experience with a large number of Massco-Grigsby Pinch Valves in its plants at Homeland and Clear Springs, the Virginia-Carolina Chemical Corporation purchased approximately 200 M-G valves for its new phosphate plant at Nichols, Florida. These valves were sold and serviced by Mine and Smelter's Sales Agent, R. H. Clark Equipment Co., Inc., Mulberry, Florida.



Two 12" Massco-Grigsby Hydral-Air Pinch Valves on mill tailings line at the Clear Springs Plant of Virginia-Carolina Chemical Corp. Valve system includes solenoids for remote push button control of opening and closing the valves.



Four 6" and four 8" Massco-Grigsby Pinch Valves on the suction and discharge sides of the pumps at Virginia-Carolina Chemical Corporation's new Nichols plant.

Photo courtesy of Westinghouse Electric

## Special Advantages of Massco-Grigsby Valves

- Rubber, Neoprene and special compounded rubber sleeves for corrosive and abrasive pulps and liquids.
- Patented "hinged" sleeve. Recesses serve as "hinges" during compression; reduce strain and permit tight closing.
- Unobstructed flow eliminates high friction loss, prevents contamination.

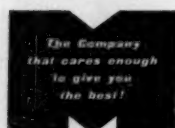


## New Automated Systems

The Massco-Grigsby Hydral-60 System consists of one or more pinch valves with a single automatically operated hydraulic pump which may be operated by electric motor or air from normal plant supply system . . . permits controlled circuitry for any operating requirement.



**WRITE FOR NEW CATALOG NO. 609**



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LICENSED MANUFACTURERS AND SALES AGENTS in Canada, Australia, Sweden, England, South Africa  
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and in principal cities of the U. S.

## CPI NEWS BRIEFS . . .

Atlantic and Western New York districts. New district headquarters are in Haddonfield, N. J.

Ingersoll-Rand Co., the air- and gas-compressor manufacturer, has opened four new branch offices: Hartford, Conn.; Moline, Ill.; Midland, Tex.; and Indianapolis, Ind.

Parke, Davis & Co., Ltd., will open another Canadian district office in Winnipeg, Man., this July. A \$150,000 office-warehouse building is now under construction, mapped to serve as headquarters for the pharmaceutical firm's combined Manitoba and Saskatchewan operations.

## Companies

Honolulu Oil Corp., San Francisco, has decided to dissolve, sell its assets for a total \$380 million to some dozen competitors. Among them: (1) Tidewater Oil Co., which would get substantially all of Honolulu's oil and gas properties in California, plus half its Alaskan properties; (2) Pan American Petroleum Corp., an affiliate of Standard Oil Co. (Ind.), which would acquire the other half of the disbanding firm's Alaskan fields, plus virtually all its land in the Midwest, Southwest and Canada.

Cryogenics, Inc., Stafford, Va., has bought Wakit Instruments Corp., Falls Church, Va., for an undisclosed amount of stock. Both firms make cryogenic hardware and systems. Announcing the acquisition, Cryogenics, Inc., served notice that the move represents "the first step in a planned growth program."

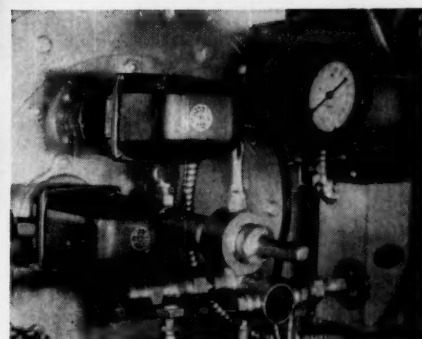
Pacific Foundry and Metallurgy Co., San Francisco open-hearth and other heavy-equipment manufacturer, has purchased The C. O. Bartlett & Snow Co., Cleveland-headquartered fabricator of kilns, calciners and other process hardware. Terms of the deal were not disclosed.

The Glidden Co., Cleveland, has bought McPhran Corp., a Marietta,





# Burner flame on? New FLĀMON Detector can help you be sure!



Two FLĀMON Detectors installed for independent monitoring of main burner flame and pilot flame of a gas-fired boiler.

Properly installed, the FLĀMON Detector *responds only to the flame it surveys*. Glowing refractories—or flames from adjacent burners—do not produce false signals. Positive monitoring of each burner is assured. Absence or failure of flame is sensed and accurately signaled—and transmitted to control auxiliaries—without use of external relays or amplifiers.

**Key to automation . . .** the FLĀMON Detector provides the key to reliable automatic light-off and shutdown.

**Provides wide temperature range . . .** the FLĀMON Detector can be used in ambient temperatures from

–20 to 150°F. Flame-sensing element withstands temperatures up to 500°F.

**Allows easy inspection . . .** quick-disconnect, key-hole mounting simplifies checking of lens condition and detector alignment.

**Simple, solid-state circuitry . . .** the FLĀMON Detector unit contains only 10 components.

**Weatherproof construction . . .** design of Bailey unit makes it suitable for outdoor installation.

Your local Bailey Engineer can give you a demonstration of the FLĀMON Detector. Call him, or write Cleveland.



CP 162-1

**Chemical and petroleum division**

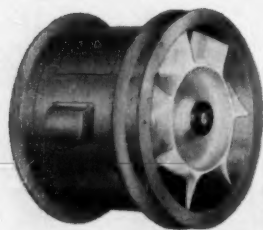
**BAILEY METER COMPANY**

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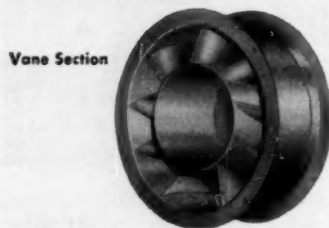
In Canada—Bailey Meter Company Limited, Montreal



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**vaneaxial fans**  
with removable  
vane sections

Engineered for high-pressure, high-velocity air distribution systems, these units feature a unique removable vane section which simplifies installation and permits easy access for routine cleaning and maintenance.

Available in 30 models in sizes 18" to 48" for capacities from 3230 to 67,300 cfm with special design features for all application requirements.

Write for Bulletin 475

All deliveries of Aerovent equipment determined in accordance with established and accepted codes and guaranteed by manufacturer.



**Aerovent**  
**FAN COMPANY, INC.**  
Ash and Bard Streets Piqua, Ohio

## CPI NEWS BRIEFS . . .

Ga., fabricator of glass-fiber panels. A Glidden spokesman says the move is a "logical extension of the company's developments in polyester resins and color pigmentation." One of Glidden's major paint plants and its regional division headquarters are in Atlanta, 15 miles from McPhran's operations in Marietta.

Diamond Alkali Co.'s board of directors has approved a proposal to merge the corporation with both The Bessemer Limestone and Cement Co., Youngstown, Ohio, and Chemical Process Co., San Francisco. Diamond's stockholders meet in Cleveland on Aug. 15 to vote on the plan.

The Foxboro Co., Foxboro, Mass., wants to acquire the assets of Waugh Engineering Co., Van Nuys, Calif., in exchange for \$126,000 in cash and 12,806 shares of common stock. Waugh recently stirred trade interest by its installation of a continuous, automated in-line blending system at Union Oil Co.'s Wilmington, Calif., oil refinery (*Chem. Eng.*, May 29, p. 46).

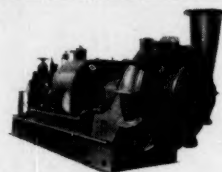
Amerace Corp., New York, has acquired Swan Rubber Co., Bucyrus, Ohio, for slightly over \$22 million in cash. Swan makes plastic and rubber garden and industrial hose, shows a net annual profit of about \$2 million; Amerace earned \$3.3 million in 1960, manufactures a variety of consumer items from combs to bowling balls.

## International

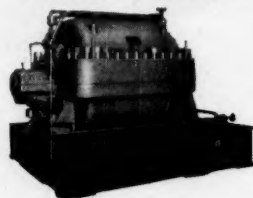
**Great Britain:** British Aluminium Co., Ltd., plans a \$28-million expansion of its aluminum rolling mill at Falkirk, Scotland. Major item on the construction slate is a 172-in.-wide hot mill, said to be the world's widest. Project is Britain's third to be announced in the past few weeks (others: Alcan Industries' \$28-million expansion at Newport, Monmouthshire, and James Booth Aluminium's program for Birmingham). Only American

## Why Ingersoll-Rand can supply EXACTLY WHAT YOU WANT in a Centrifugal Compressor

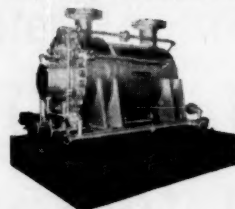
MORE TYPES AND SIZES to choose from



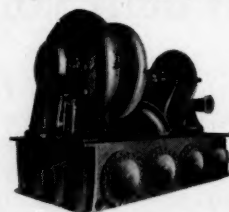
Single-Stage Units  
Pressures to 1000 psi  
Capacities to 700,000 cfm



Multi-Stage, Horizontally Split  
Pressures to 800 psi  
Capacities to 200,000 cfm



Multi-Stage, Vertically Split  
Pressures to 5500 psi  
Capacities to 20,000 cfm



Intercooled 100-psi Units

These four basic casing types can be combined into multiple-unit installations to meet any pressure and capacity requirement. And every design features . . .

**GREATER ADAPTABILITY** to meet your specific needs. Seals, cooling methods and side-load connections are just a few of the many design details that can be "tailored" to each installation. What's more, every compressor is backed by . . .

**MORE THOROUGH TESTING** in the world's largest and best-equipped compressor test facility. Here new centrifugal designs, components, accessories and complete machines can be tested, frequently at full load and under simulated operating conditions.

**5 MILLION HORSEPOWER** of I-R centrifugal compressors are serving all types of applications throughout industry.

263A12

**Ingersoll-Rand**



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Adding new dimensions

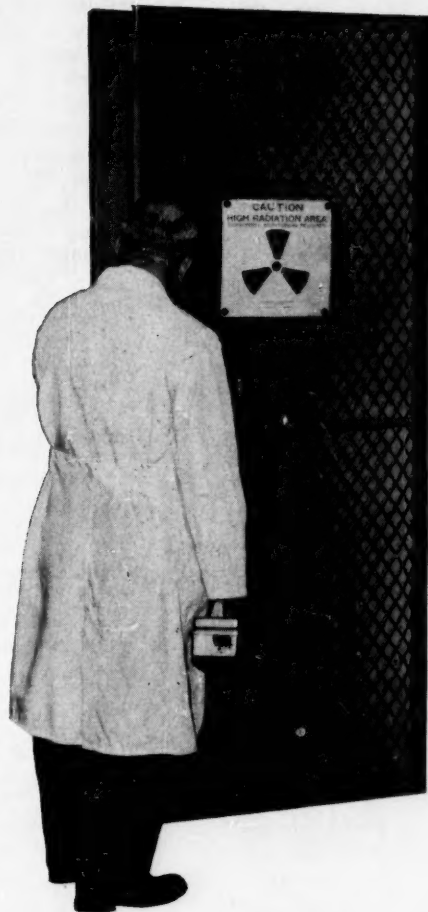


to engineering

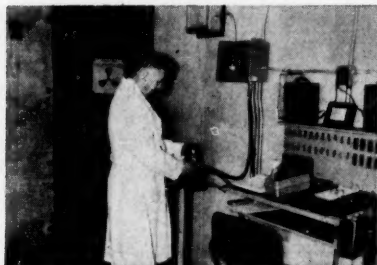
## Behind this door...

**gamma- and X-rays  
stop centrifugal compressor  
problems before they start**

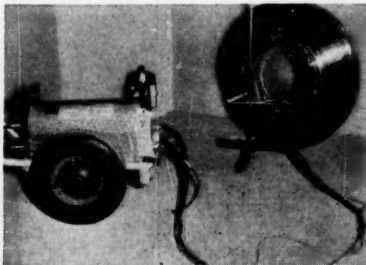
We inspect centrifugal compressors *from the inside-out* at our new Non-Destructive Testing Laboratory. Using cobalt 60, iridium 192 or 160-KV X-ray equipment, we look all the way through centrifugal compressor parts to be certain they are free from defects. This extra care in manufacture means extra dependability in the field. It's another reason why users of Ingersoll-Rand centrifugal compressors can expect...and get...more reliable, trouble-free operation.



Controlled from a remote station...gamma rays probe deep...to provide visible internal inspection



At one of 3 test stations, an Ingersoll-Rand radiographer uses remote controls to place radioactive pellets of iridium or cobalt in the exposed position...



...within the thick concrete test cell. The gamma rays penetrate the compressor part and expose the film. The radioactive pellet is then returned to its shielded container.



The developed radiographic view is carefully inspected by I-R metallurgists to be certain that the part is free from defects. Radiography is one of many non-destructive testing methods used by Ingersoll-Rand.

**THE WORLD'S MOST COMPREHENSIVE  
COMPRESSOR EXPERIENCE**

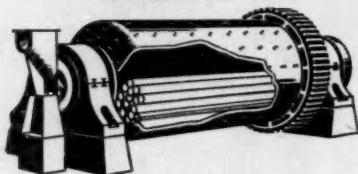


**Ingersoll-Rand®**  
260A12 11 Broadway, New York 4, N.Y.

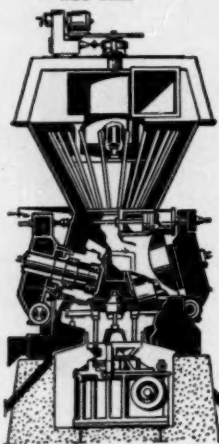
# GRINDING AND PULVERIZING



CASCADE® MILL



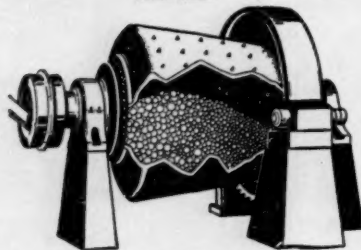
ROD MILL



DISC-ROLL MILL



TUBE MILL



CONICAL AND TRICONE MILLS

No matter what your grinding problem—coarse or fine grind—ball, pebble or autogenous — Hardinge has a mill for the job.

## CASCADE® MILL

A continuous mill using the autogenous grinding principle—large pieces of material grinding the smaller ones. Shape of the mill causes maximum "free fall" and impact. Feed is divided into coarse and fine components and re-combined in proper proportion for best grinding.

## ROD MILL

Steel rods are employed as grinding media. Ideal for producing minimum oversize in open circuit grinding. Conical heads prevent "choking" of the charge at the ends, and align the rods. Available with either end, or center, peripheral discharge, as well as trunnion overflow.

## DISC-ROLL MILL

A roller-mill with rotating grinding table and spring-loaded rolls. The "Gyrotor" Classifier, combined with the Disc-Roll Mill, provides a highly-efficient dry-grinding device, ideal for relatively soft minerals.

## TUBE MILL

For a fine product in open circuit without the use of classifiers. For mixing and grinding to secure a smooth texture or plastic product. Often used as an autogenous grinding mill.

## CONICAL MILL®

The shape of the Hardinge Conical Mill causes a rapid circulating and classifying action within the drum, which increases the capacity for power expended over other types. The range of grinding is large, due to segregation of media and material within the mill.

## TRICONE® MILL

Built on the same principle as the Conical Mill, the Tricone Mill offers greater grinding volume for a given amount of floor space than any other tumbling mill built. Extremely efficient. Ideal for large tonnages. Sizes up to 12 ft. diameter.

\* Trade Mark

Consult your nearest Hardinge office, giving them full details of your grinding problem.

## CPI NEWS BRIEFS . . .

aluminum-making subsidiary left to announce an expansion is Aluminum Co. of America's Impalco offshoot.

**United Arab Republic:** Construction has begun on another state refinery at Suez, this one designed not only to feed the projected petrochemicals complex at the site (*Chem. Eng.*, May 15, p. 202) but also specifically to curb the country's growing deficit in midbarrel distillates. Compagnia Tecnica Industrie Petroli, S.p.A., Rome, is erecting the \$70-million facility under a \$27-million first-phase contract. When completed during the second quarter of 1963, refinery will process 33,200 bbl./day of skimmed crude from the Belayim oil field (plus some naphtha, asphalt and wax distillates from the Soviet-built lube oil plant at Suez). Output: 2.3 million metric tons/yr. of petroleum products, ranging from light naphtha and kerosene to diesel oil.

**Canada:** British American Oil Co., Ltd., plans to build Canada's first cyclohexane plant at Clarkson, Ont., or Montreal East. No capacity figures on the multimillion-dollar facility have been released, but Du Pont is understood already to have signed for most of the output (to feed its nylon plant in Maitland, Ont.).

**India:** Madras Aluminium Co. has been created by Montecatini S.p.A., Milan, Italy, apparently in consort with several unidentified Indian concerns. New firm will build a 10,000-ton/yr. aluminum mill in Madras State, produce both ingots and alloys from local bauxite.

**Nigeria's** Bauchi plateau, major tin-producing region, has its own smelters for the first time since deposits were dug 60 years ago (until now, ore has been shipped to Liverpool for extraction). Nigerian Embel Tin Smelting Co., Ltd., a Portuguese firm, has a plant at Jos that daily reduces five tons of ore to three tons of metal, with capacity scheduled for an eightfold hike by the end of the year. Also at Jos, Makeri Smelting Co., Ltd., is build-

# HARDINGE

## COMPANY, INCORPORATED

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"Hardinge Equipment—Built Better to Last Longer."

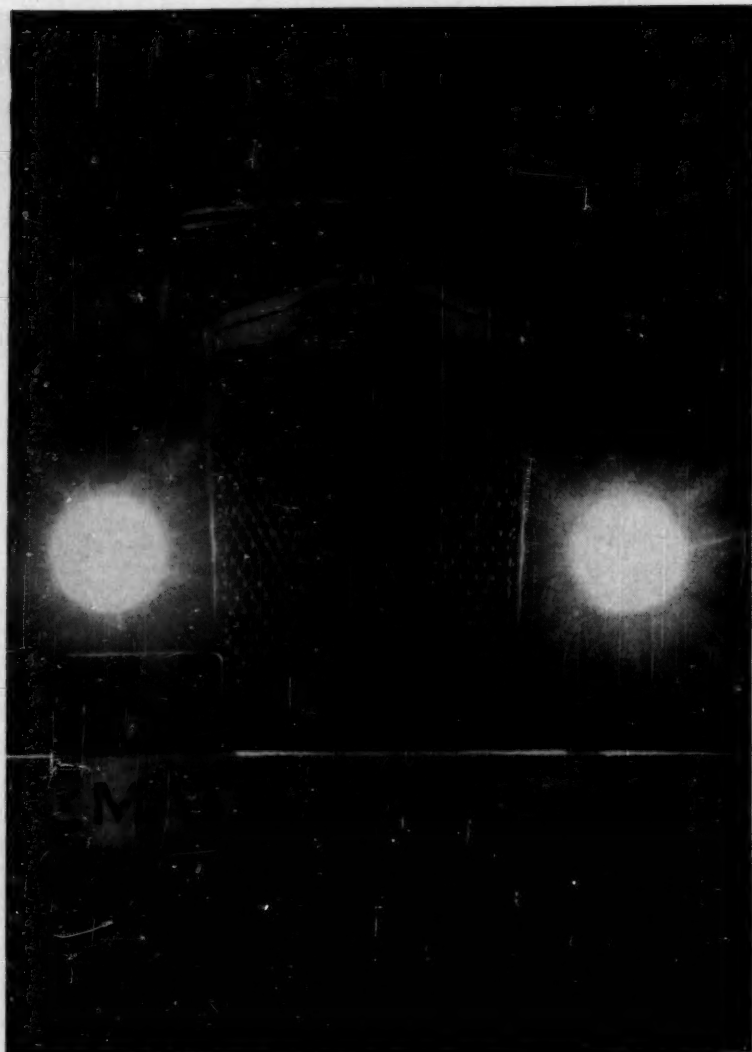
NEW YORK  
TORONTO  
CHICAGO  
HIBBING  
SALT LAKE CITY  
SAN FRANCISCO  
HOUSTON  
LAKELAND  
BIRMINGHAM

A black and white photograph of a large industrial machine, likely a steam engine or pump. The machine is characterized by a prominent horizontal beam or piston rod extending across the frame. Below this beam, a large flywheel is visible, partially obscured by a complex network of metal supports and structural elements. The overall appearance is that of a heavy-duty mechanical device, possibly used in a maritime or industrial setting. The lighting is dramatic, with strong highlights and deep shadows, emphasizing the metallic textures and the scale of the machinery.

**Mineral Insulated Cable is the most versatile and economical wiring you can use, for jobs up to 600 volts. Even under the worst conditions, it works beautifully. ■ In the MI Cable job shown here, for instance, in spite of temperatures to 200 F and humidity to 95%, there's been no trouble whatever in three years of continuous operation. ■ But get details on MI Cable and see for yourself how it might work for you. Write for Catalog S-2. General Cable Corporation, 730 Third Ave., New York 17, N.Y.**

167






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When you want carbon dioxide fast, call your nearby Olin Mathieson warehouse. Our truck fleet and rail cars deliver CO<sub>2</sub> around the clock. In any form. In any quantity. For any use. To any place.

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### CPI NEWS BRIEFS . . .

ing a companion 30-ton/day smelt, due completed in August.

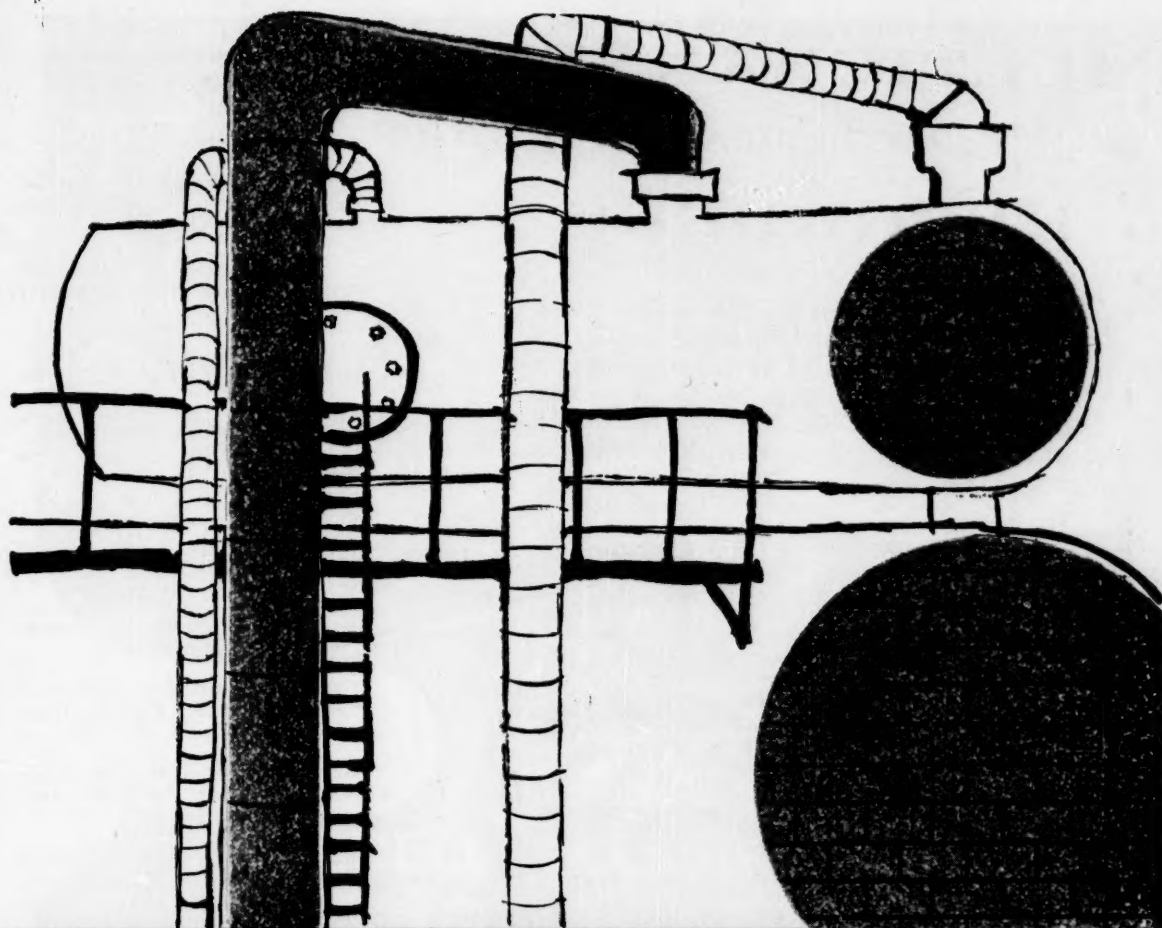
**Brazil:** Diamond Alkali Co. has joined a Panamanian investment house to purchase a half interest in Carbocloro-Industrias Quimicas Ltda., Rio de Janeiro. Capitalization of the Rio firm has been increased by \$4 million to expand its caustic/chlorine plant at Sao Caetano, Sao Paulo province, and to build a new unit at Cubatao. Sao Caetano facility will daily make 200 tons of chlorine, 220 tons of caustic soda, lesser outputs of by-product hydrochloric acid and bicalcium phosphates.

**West Germany:** Girdler-Sudchemie Katalysator GmbH., a jointly owned subsidiary of Sudchemie A.G., Munich, and Chemetron Corp., Chicago, has begun constructing a specialty-catalyst plant at Moosburg, near Munich, in upper Bavaria. Main production will be Girdler catalysts for routes to ammonia, fatty acids, edible oils and other petrochemicals.

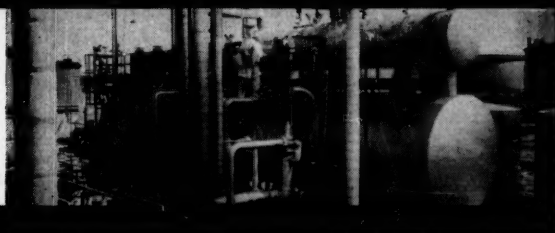
**South Africa:** Electrolytic Metal Corp., a five-firm venture, has begun electrolytically reclaiming 2,400 tons/yr. of manganese from uranium-oxide plant waste in the Transvaal. Output is already scheduled to be doubled. Limited domestic demand dictates almost total export of the highly pure metal.

**Greece:** Dow Chemical Co. made its first move into the Near East last month with the laying of foundation stone for a \$1-million polystyrene plant in Lavrion, Greece. Due on stream early next year, facility will make the nation self-sufficient in polystyrene (2,400 tons were imported in 1960).

**Japan:** Karonite Chemical Co., Ltd., is a newly created subsidiary of California Chemical Co., Kao Soap Co., Ltd., and Nomura Jimusho, Inc. New firm will spend \$2 million to build a plant this winter at Kawasaki, near Tokyo, in which to produce 2 million gal./yr. of finished lube-oil additives and 500,000 gal./yr. of alkyl phenols.



## **FOAMGLAS® Insulation works for CALIFORNIA OIL COMPANY**



**EVIDENCE:** In 1951, California Oil Company selected FOAMGLAS Insulation for their alkylation plant at their Perth Amboy, New Jersey, refinery. Ten years later FOAMGLAS is still delivering consistent service, temperature control and fire protection on reactors, drum exchangers, and piping in the complex high octane blending operation.

Long-lasting, trouble-free insulation is a result of the completely waterproof nature of FOAMGLAS. The inorganic insulation ignores moisture, keeps a constant K-value and lasts for the life of the equipment. The closed glass cell composition holds temperatures at the required 30°F to 60°F in outdoor alkylation units and piping.

Another important benefit for California Oil is the incombustibility of FOAMGLAS, reducing fire hazards. And FOAMGLAS protects against smoke, dirt and acids in the refining operation.

Let FOAMGLAS solve your most demanding insulation problem above or below ground, indoors or out, on

piping, tanks, equipment, valves or fittings. For more details, write to Pittsburgh Corning Corporation, Dept. H-61, One Gateway Center, Pittsburgh 22, Pa. In Canada: 3333 Cavendish Blvd., Montreal, Quebec.

**Pittsburgh Corning makes available a complete line of accessory materials for use with FOAMGLAS. Write for Data Sheets.**

**PITTSBURGH**



# MULTICHANNEL

## RECTILINEAR

# RECORDERS

Variable-width channel operation provides simultaneous recording of two to six different signal functions on a single chart. Curtiss-Wright has the only rectilinear recorder available with this combination of features. Simple operation, versatility, dependable performance and compactness assure optimum flexibility for a wide range of applications.



#### Advantages and Features:

**Versatility**—Wide choice of ranges, chart drives, and speeds. AC and DC Movements.

**Accuracy**— $\pm 1\%$  of full scale for DC movements. Sensitivity down to  $250 \mu\text{A}$  DC. May be extended by optional DC amplifier.

**Optimum Reading Ease**—Rectilinear ink or inkless recording provides undistorted signal traces.

**Utmost Reliability**—Inherently self-shielding, permanent-magnet, moving-coil movements eliminate tubes, choppers, motors and slidewires.

**Ruggedness**—Shockproof suspension with dustproof, splashproof and anti-magnetic construction.

#### Standard Size Model

1, 2 or 3 channels  
Portable, flush mount or projection  
switchboard and wall mounting  
Weight: 19 lbs.  
Size:  $7\frac{1}{2}'' \times 9\frac{1}{4}''$  high  
 $\times 7\frac{7}{8}''$  deep

#### Double Size Model

2, 3, 4, 5 or 6 channels  
Portable, flush mount or projection  
switchboard and wall mounting  
Weight: 26 lbs.  
Size:  $12\frac{3}{4}'' \times 9\frac{1}{4}''$  high  
 $\times 8\frac{3}{8}''$  deep

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**CURTISS**  **WRIGHT**  
Princeton Division CORPORATION Princeton, New Jersey

## Convention Calendar

### July

3-7. Gordon Research Conference, Polymers, Colby Junior College, New London, N. H.

4-7. National Society of Professional Engineers, Annual Meeting, Olympic Hotel, Seattle, Wash.

10-14. Society of the Chemical Industry, Annual Meeting, Oxford, England.

10-14. Colorado State University, Fourth Annual Institute in Technical and Industrial Communications, Fort Collins, Colo.

10-29. Case Institute of Technology, Process Control Theory Course, Cleveland, Ohio.

17-21. National Assn. of Power Engineers, National Convention, Sheraton-Gibson Hotel, Cincinnati, Ohio.

17-21. Gordon Research Conference, Organic Coatings, Kimball Union Academy, Meriden, N. H.

18-20. Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, Calif.

24-28. Gordon Research Conferences, Corrosion-Oxidation of Metal Surfaces, Colby Junior College, New London, N. H.

31-11. Case Institute of Technology, Digital Control Systems Course, Cleveland, Ohio.

### August

3-5. Chemical Institute of Canada, Annual Conference and Exhibition, Queen Elizabeth Hotel, Montreal, Que.

7-11. Gordon Research Conferences, Separation and Purification, Colby Junior College, New London, N. H.

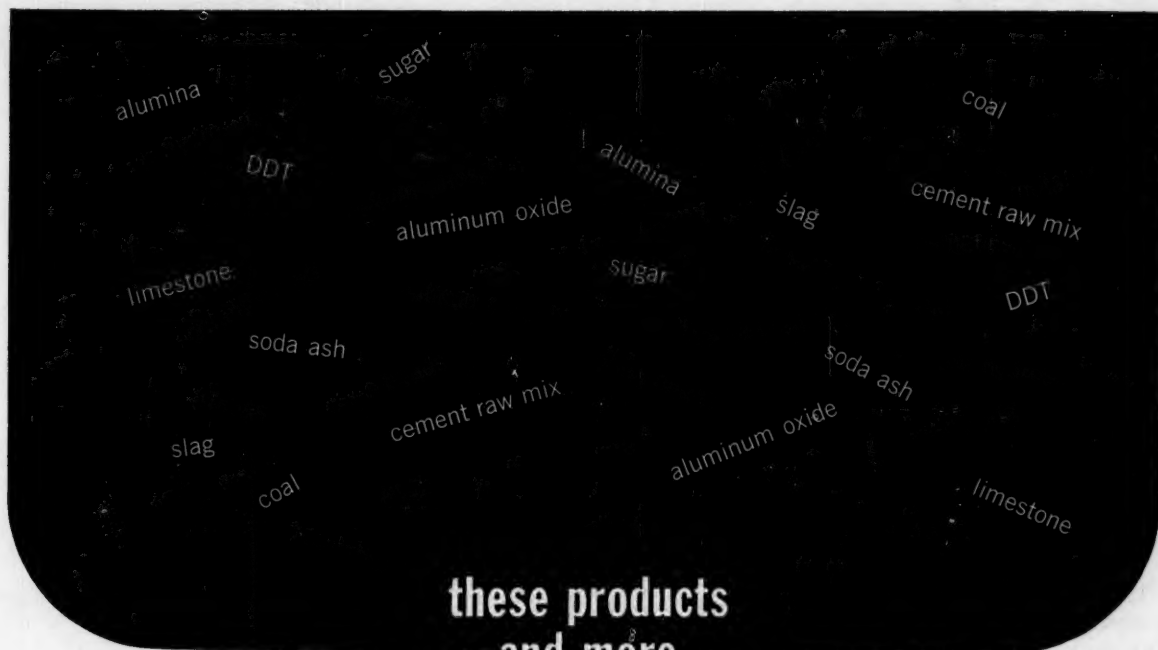
7-11. Gordon Research Conference, Statistics in Chemistry and Chemical Engineering, New Hampton School, New Hampton, N. H.

14-17. Louisiana State University, Ninth Annual Short Course in Fundamentals of Occupational Safety, Baton Rouge, La.

14-18. Gordon Research Conference, Instrumentation, Colby Junior College, New London, N. H.

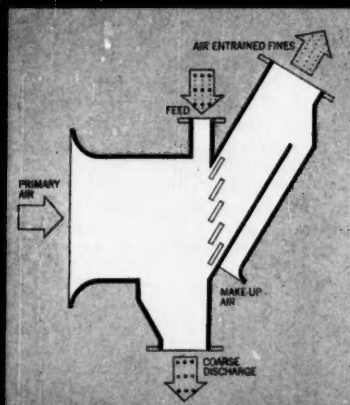
15-17. University of Michigan, Cryogenic Engineering Conference, Ann Arbor, Mich.

15-18. Technical Assn. of the Pulp and Paper Industry, Testing Conference, Queen Elizabeth Hotel, Montreal, Que.

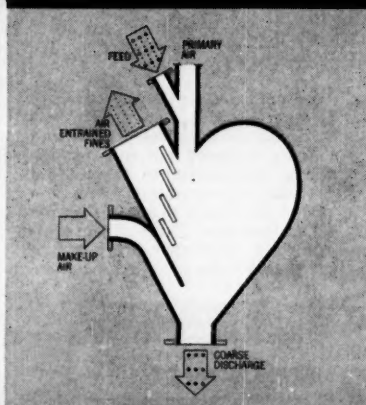


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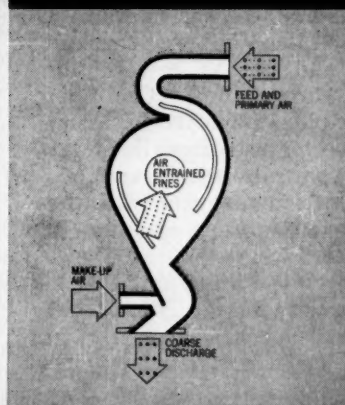
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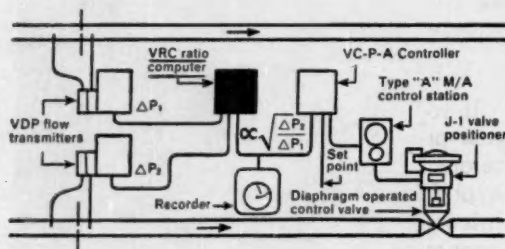
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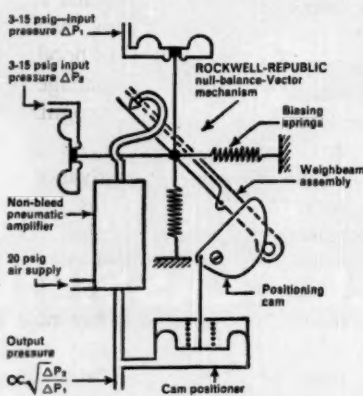


This flow ratio control system is a typical application of a VRC Ratio Computer. Rockwell-Republic produces all components including orifice sections and control valves required for this system. You get the added value of one-source responsibility.

The new Rockwell-Republic VRC ratio computer replaces a conventional ratio device and two square root extracting mechanisms in the flow ratio pneumatic control system shown above. Flow ratio may be directly recorded. The VRC is the newest addition to the Rockwell-Republic family of Null-Balance Vector instruments. These compact, lightweight, 3 to 15 psig pneumatic control instruments include the VDP flow transmitters and the VC-P controller, also shown above. One basic principle is employed by the entire vector instrument line. Thus, spare parts inventories and training problems are simplified when these instruments are used together.

For more information about these and other Rockwell-Republic instruments and controls, just mail the coupon below.

RF-25



This schematic of the VRC Ratio Computer shows how a cam controls position of the weighbeam and thereby controls the null-balance vector mechanism so that output pressure is proportional to the ratio of the two input pressures or the actual flow ratio. Shape of cam characterizes relationship of output pressure to ratio of input pressures.



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### CALENDAR . . .

21-31. United Nations Conference on New Sources of Energy, Ciro Massino, Rome, Italy.

21-1. Wayne State University, International Conference on Coordination Chemistry, Detroit, Mich.

22-25. Western Electronics Show and Conference, Cow Palace Hotel, San Francisco, Calif.

28-31. Mathematical Assn. of America, Summer Meeting, Oklahoma State University, Stillwater, Okla.

28-1. American Society of Mechanical Engineers, International Conference on Heat Transfer, University of Colorado, Boulder, Colo.

### September

3-8. American Chemical Society, National Meeting, Chicago, Ill.

6-8. Assn. for Computing Machinery, Annual Meeting, Statler-Hilton Hotel, Los Angeles, Calif.

6-8. Massachusetts Institute of Technology, International Symposium on Transmission and Processing of Information, Cambridge, Mass.

11-15. Instrument Society of America, 16th Annual Instrument-Automation Conference & Exhibit, Biltmore Hotel and Memorial Sports Arena, Los Angeles, Calif.

11-15. National Industrial Conference Board, Stanford Research Institute, International Industrial Conference, Fairmont Hotel, San Francisco, Calif.

12-15. Pennsylvania State University, Seminar for Manufacturing Engineers, University Park, Penna.

14-15. American Society of Mechanical Engineers, American Institute of Electrical Engineers, Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

17-22. Pennsylvania State University, Work Measurement Course, University Park, Penna.

24-27. American Institute of Chemical Engineers, National Meeting, Lake Placid, N. Y.

### Later

October 11-12. CHEMICAL ENGINEERING and Armour Research Foundation, Conference on the New Trends in Chemistry, Sheraton Towers Hotel, Chicago, Ill.

November 27-December 1. 28th Exposition of the Chemical Industries, New York Coliseum, New York, N. Y.

## Engineering-Management Status: Dream or Mirage?

### Technology an asset, but other training required

The complexity of modern industry has created a great demand for management personnel with engineering training. Surprisingly, there is a very short supply of such men, i.e., engineers with enough potential to be groomed for executive functions.

Historically, as big industry moved out of restricted, private ownership into broader public ownership, two things happened, both of which added to the demand for "management men." First, public ownership made possible more diversified management, as opposed to the centralized control characteristic of family ownership. Second, the complications and diversification of modern industry have sharply increased the ratio of executives to employees. Where the ratio was formerly approximately one executive to 100 employees, it is now more like one to 35.

Recognizing that employment has increased by about one-third during the same period, the need for management personnel becomes clearer. Not only do few engineers graduate from school ready to be managers, few of us study courses as undergraduates which would prepare us for executive leadership later in our careers. Finally, as a prerequisite for managing

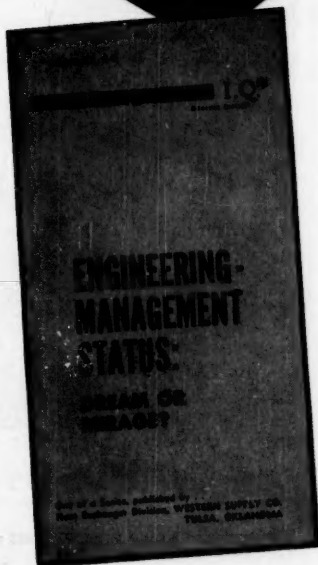
the affairs of others, there is no substitute for experience.

#### WHAT DO YOU REALLY WANT?

If you are facing this important decision in your present status, get your future into focus before taking the step. Decide what you really want from your personal and business careers. It is sometimes too easily assumed that all men want to move on to higher, executive positions. With few exceptions, all men pay lip service to "wanting to get ahead," but too many of us hoodwink ourselves into believing this means management responsibilities, without fully recognizing the significance of such a step.

As a matter of fact, all men *don't* want to advance into management. Some, however, find this out too late, for unless they are psychologically and emotionally suited for the rigors of management, the driving ambition to assume more leadership, responsibility and authority may not in itself be a worthwhile goal. If a man is doing well where he is, it may be a mistake for him to try to move into the management orbit, for the move to management is not the only door to advancement.

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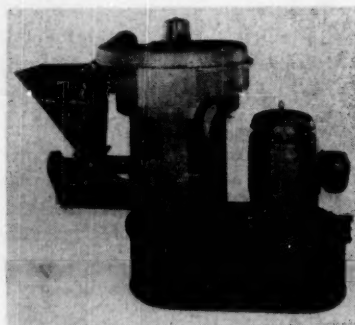
### NEW EQUIPMENT . . .

*continued from page 86*

Eccentric drive of the screens provides a linear oscillation that conveys material uniformly across a screen without sliding. The drive is self-adjusting, continues full-stroke action regardless of load. A connecting rod transmits power from the motor gradually, constantly adjusting to the actual needs of the screen.

Drive springs keep the decks oscillating one against the other, storing and releasing energy so that a minimum of additional power is required from the motor. Units are available for classifying, washing, dewatering, conveying.

—Comco Corp., Philadelphia. 86D



### Pulverizer-classifier

**Unit reduces material to 1-micron size and accurately classifies it.**

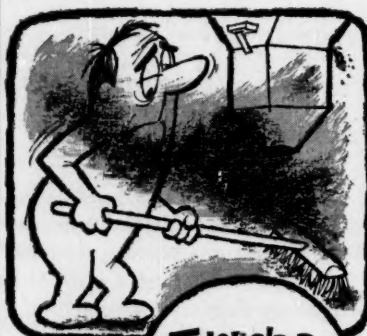
Featuring accurate control of particle size in the low-micron range, the Hurricane Pulverizer-Classified can be used to reduce and classify cellulose derivatives and other dry products.

The unit, an air attrition mill, has processed to 1,500 lb./hr. of hydroxy ethyl cellulose in manufacturer's tests. It also has been used on sodium carboxy methyl cellulose.

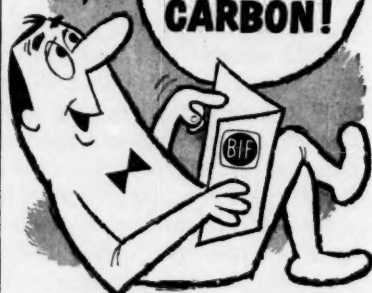
Outside the chemical field, the unit has applications in the reduction of pigments, asbestos, food ingredients, and any other application requiring fine grinding of dry material.—The Bauer Bros. Co., Springfield, Ohio. 174A



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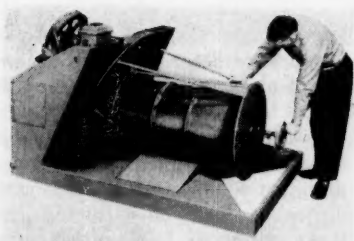
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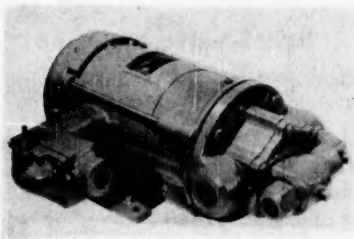
### Drum mixer

**Stirs up and disperses contents of closed 55-gal. drums.**

Mixing the contents of a closed 55-gal. drum is easy with the NiMixer. Using a rotary, oscillating motion, the mixer accepts full drums weighing up to 1,000 lb., mixes the contents faster than they can be mixed with a paddle mixer, according to the manufacturer.

Advantages of total-drum mixing include decreased evaporation losses, elimination of odors or possibly explosive vapors, no contamination of the contents, and less handling of materials.

One man can load or unload the device by rolling a drum onto a lowered cradle where it is centered by hydraulic jacks. After a screw clamp and lock nut are tightened, hydraulic cylinders swing the cradle into operating position, and mixing begins. The mixer is driven at 30 rpm. by a 1-hp. motor, with practically no vibration.—**National Industries, Jackson, Mich. 175A**



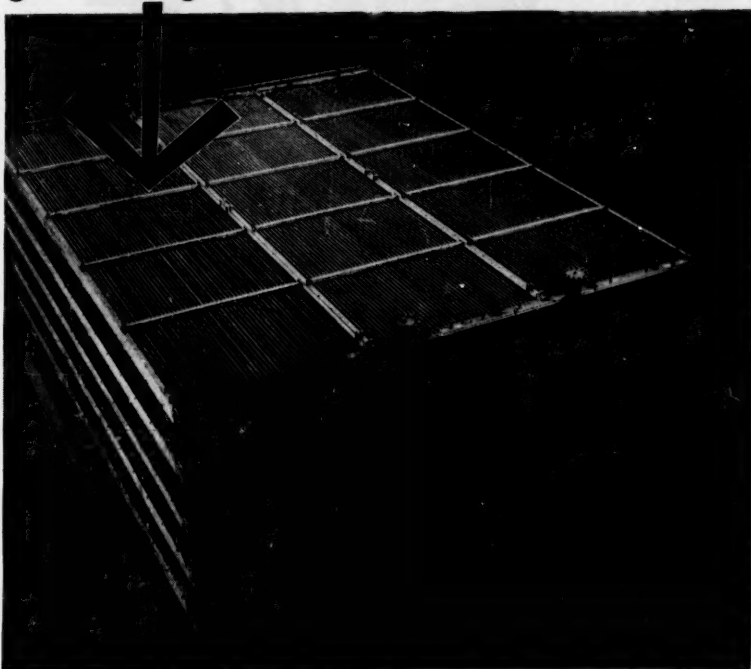
### Rotary pump

**Motor and pump are integral with a common, heavy-duty shaft.**

A motor-mounted rotary pump handles clean liquid and solvents at delivery rates from 10 to 30

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### **Griscom-Russell designs and builds record heat exchanger with 525 miles of Alcoa Aluminum coiled sheet**

World's largest single-cell fin-fan unit, this air-cooled heat exchanger (cut shows cooling sections only) was installed in a major European refinery. Designed and built by Griscom-Russell Co., Massillon, Ohio, it cools heavy hydrocarbon liquid over a 300°F range. Containing 525 miles of Alcoa® Aluminum coiled sheet, the unit has a total cooling surface of 267,000 sq ft. Advantages of aluminum: high thermal conductivity, corrosion resistance and low cost. For more information, please mail the coupon.



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- ☐ 68-10460 *Process Industries Applications of Alcoa Aluminum*  
☐ 34-11566 *Alcoa Aluminum Heat Exchanger Tubes*

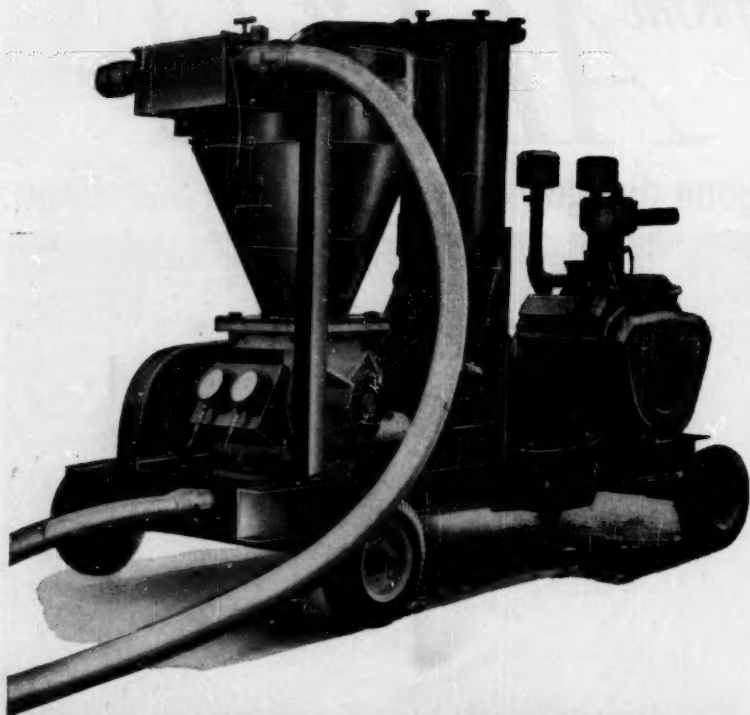
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See Chemical Engineering Catalog for further details and specifications.



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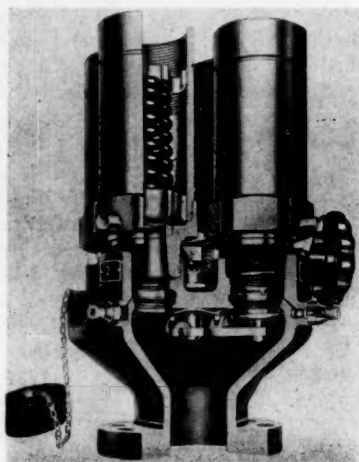
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A296

## NEW EQUIPMENT . . .

gpm. and pressures to 125 psi. Pump and motor are built as integral unit, share a common shaft supported by the motor bearings.

Integral mounting eliminates need for pump bearings, a coupling or a mounting base. Pump discharge can be directed up, down, right or left by removing four cap screws and repositioning the cylinder. Built-in relief valve bypasses pump in the event of excessive pressure.

The mechanical seal on the shaft requires no adjustment or special tools to replace; a small hole between seal and motor flange gives immediate evidence of seal failure. Pump vanes, when critically worn, are replaced without disconnecting suction or discharge piping.—Blackmer Pump Co., Grand Rapids, Mich. 175B



## Relief valve manifold

Connected directly to tank opening, system needs no inlet piping.

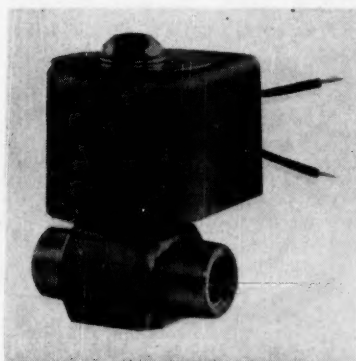
Available with 2, 3 or 4 valves in threaded mounts, a safety relief manifold system bolts directly to a flanged tank opening, needs neither inlet piping nor shutoff valves.

Dual relief-valve systems are superseded by this unit because a handwheel selectively closes off the entrance port to a particular safety valve being removed for servicing. Manifolds are sized to permit such removal while the

storage container is under full pressure, without losing full discharge capacity.

Valves open only slightly to relieve moderately excessive pressures, but pop open to full capacity when tank pressure increases beyond 120% of the set pressure. After discharging, the valves reseat automatically and firmly, according to the manufacturer.

Available in brass-ferrous or all-ferrous construction, valves operate at set pressures between 40 and 300 psi.—The Bastian-Blessing Co., Chicago. 176A



### Cryogenic solenoid valve

Packless two-way unit comes in brass or stainless steel.

Designed for cryogenic service in the range from -100 to -460 F., a midget solenoid valve has integral seat and Teflon disk. It mounts in any position, gives tight shutoff for liquids, slight leakage with gases.

An optional waterproof solenoid is available with the valve—which comes in  $\frac{1}{8}$  and  $\frac{1}{4}$ -in. sizes. Valve disk is not suitable for temperatures much higher than -100 F.—Automatic Switch Co., Florham Park, N. J. 177A

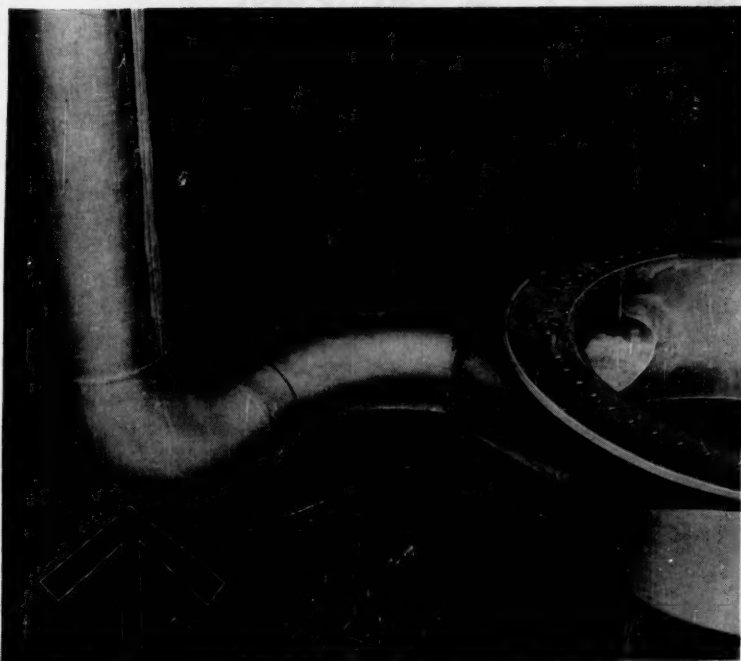
### Flexible coupling

Low-maintenance unit operates in water, oil, or mild corrosive.

Bakelite cushions, boiled in water for 5 days to prevent swelling, shrinking or possible distortion

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### Aluminum cooling system at Oak Ridge includes Tube-Turn fittings

At Oak Ridge National Laboratory, a cooling system utilizing aluminum forces more than 12,000 gal of water per minute through the research reactor. Welding fittings up to 24 in., thought to be the world's largest of aluminum, were made with Alcoa® Aluminum by Tube Turns Division of Chemetron Corporation, Louisville, Ky. Aluminum was selected to maintain purity of the demineralized water. Other advantages: aluminum's low cost, corrosion resistance and superior heat-transfer ability. To take advantage of Alcoa's 35 years of heat exchanger experience, please send the coupon.



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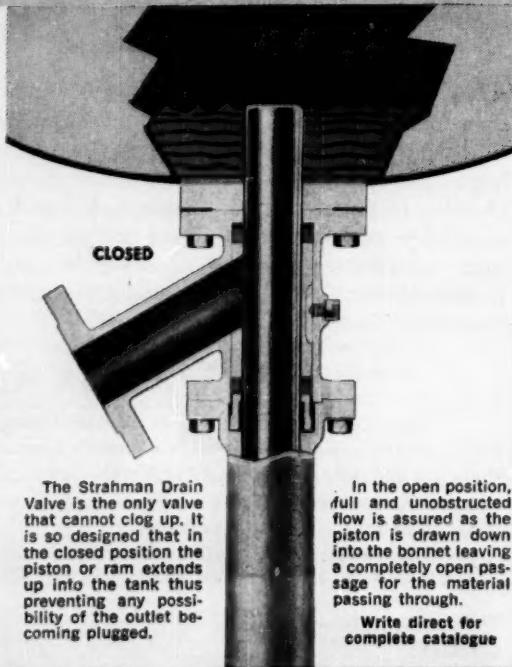
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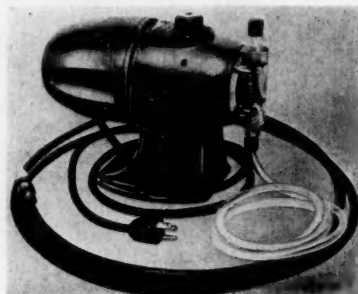
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### NEW EQUIPMENT . . .

after installation, enable this flexible coupling to operate under water for up to 3 years without maintenance. The cushions transmit the load, thereby reducing wear on the metal jaws.

The coupling bodies are of semi-steel castings, the outside collars and inside sleeves of hot-dipped galvanized metal, and the retaining bolts are stainless steel. Available in bore sizes up to 9.5 in. for loads from 2.6-hp. to 1,365-hp. at 100 rpm., the coupling contains no intricate mechanisms, can be installed quickly.—**Lovejoy Flexible Coupling Co., Chicago.** 177B



### Additive pump

**Diaphragm unit can feed 1 gph. of corrosive chemicals, at 100 psi.**

Practically any chemical solution can be pumped in amounts up to 1 gph. with this electrically driven chemical pump. Output rate is set with an adjustable dial.

Self priming, the pump operates against a pressure of 100 psi. at a speed of 30 strokes per minute. It weighs only 8 lb., works off 60-cycle, 115-v. power.—**The Bird-Archer Co., Philadelphia.** 178A

### Briefs

Flexible pipe joint slips over pipe ends, tightens with a single clamp on each end. Unit permits up to 4 deg. of misalignment, reduces pressure drop, and absorbs pump and motor noise and vibration.—**Marman Div., Aeroquip Corp., Los Angeles.** 178B

Conversion calculator provides instant conversion of metric to English units and vice versa. It also presents decimal and metric equivalents of parts of an inch as well as a number of simple conversion formulas. Centigrade and Fahrenheit temperature relationships are given from absolute zero to 3,000 C.—Kelm Mfg. Co., Coloma, Mich. 179A

Compact fire extinguisher, dry chemical type, features fast operation. When unit is picked up by the carrying handle, the safety lock automatically releases so unit will operate when the discharge lever is pressed. Total weight: only 5 lb.—Walter Kidde & Co., Belleville, N. J. 179B

Miniaturized thermocouples cover four specific applications: internal surface measurement, multiple-surface temperature measurement, liquid and gases to 3,500 psi., and liquids to 3,000 psi. Four-unit kit costs \$12.95.—Harco Laboratories, Inc., New Haven, Conn. 179B

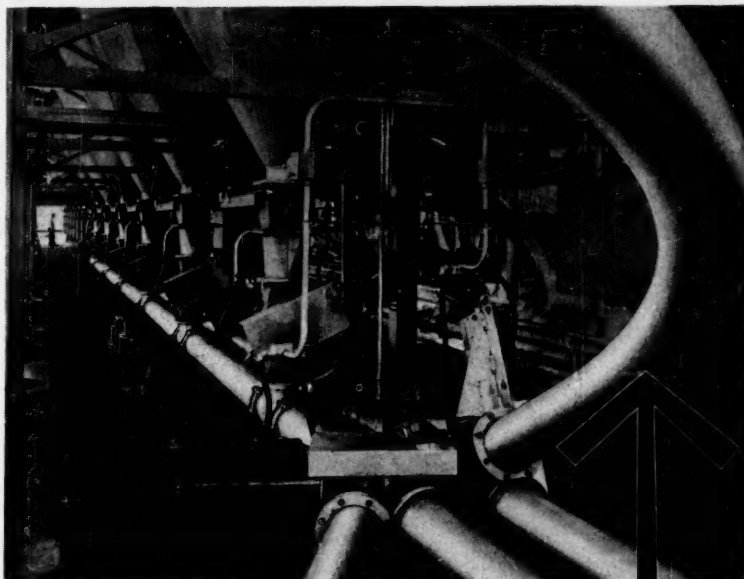
#### Equipment Cost Indexes . . .

	Dec. 1960	Mar. 1961
<b>Industry</b>		
Avg. of all . . . . .	237.3	237.2
<b>Process Industries</b>		
Cement mfg. . . . .	231.6	231.3
Chemical . . . . .	238.1	238.0
Clay products . . . . .	225.1	224.8
Glass mfg. . . . .	224.8	224.7
Paint mfg. . . . .	229.4	229.7
Paper mfg. . . . .	229.4	229.3
Petroleum ind. . . . .	234.3	234.7
Rubber ind. . . . .	237.1	237.6
Process ind. avg. . . . .	236.1	235.9
<b>Related Industries</b>		
Elec. Power equip. . . . .	238.3	237.9
Mining, milling . . . . .	239.5	239.4
Refrigerating . . . . .	268.0	268.5
Steam power . . . . .	224.5	224.9

Compiled quarterly by Marshall and Stevens, Los Angeles, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-5 for method of obtaining index numbers; Mar. 6, 1961, pp. 115-116 for annual averages since 1913.

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To prevent product discoloration, this polypropylene process employs ALCOA® Aluminum—in piping, bins, hoppers and vessels. Also, aluminum's excellent low-temperature durability is an important asset; tensile and yield strengths actually increase without embrittlement as operating temperatures drop.

Aluminum is nontoxic, has a higher strength-weight ratio than most metals, costs less to install than any other suitable material. We'd like to send you more information. Please send the coupon.



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- ☐ 68-10460 Process Industries Applications of Alcoa Aluminum

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It has been evident for some time that a more fundamental approach to teaching the classical unit operations is desirable. Many teachers have provided the fundamentals through their own lecture notes, supplementing standard texts of unit operations. Now, for the first time, both the underlying transport theories and the operative quantitative techniques are combined in an undergraduate textbook.

The professors Foust, et al., provide a fine appraisal of modern chemical engineering trends. At the same time, they uphold some of the highest virtues of teaching.

Based on several years of teaching at Lehigh University, the book contains three sections that cover stage operations, molecular and turbulent transport, and applications to equipment design. It can, according to the authors, fill nine to ten semester hours at junior level or, by selectivity, an eight-hour course. The second section can alone provide a basic three-hour course in transport phenomena for all engineers.

Though one man's order can be another's chaos, the arrangement of the book seems to me more convenient for both student and practicing engineer than some previous texts. Within the first section, for example, there is a separate chapter on simplified calculation methods and another on unsteady-state stage operations. In the second section, applications of molecular-transport theory to the steady and unsteady states are covered separately.

Two chapters on turbulent and interphase transfer serve as the transition from general consideration of transport properties to the process-design considerations of the last half of the book. In the first of these, there is an excellent discussion of transfer analogies, and in the second, the discussion is



turned from point properties to equipment design by deriving general design equations for mass, heat and momentum transfer.

One of the more valuable aspects of the Lehigh faculty's work is the continual gathering together of loose ends, not just in summaries at the end of a chapter but throughout the text, wherever it seems appropriate. By doing so, these educators perform a prime but often forgotten function of teaching: the pointing out of areas of ignorance to those who may eventually shed light on them. The discussion of the mechanism of turbulent flow is a good example.

A folio-size book, the work has clear, large line drawings and a generous number of plant and equipment photographs and cross-sections. Worked-out numerical examples are peppered throughout, and problems abound.—WCS

#### REASONABLE REFERENCE

SERVOMECHANISMS. BY P. L. TAYLOR. LONGMANS, GREEN AND CO. 418 PAGES. \$8.50.

*Reviewed by Ephraim M. Miller, The Foxboro Co., Foxboro, Mass.*

A well-written British text on the principles of closed-loop automatic control, this work assumes no previous knowledge of servomechanisms. However, most of it requires electrical knowledge on the level of an advanced undergraduate electrical engineering student.

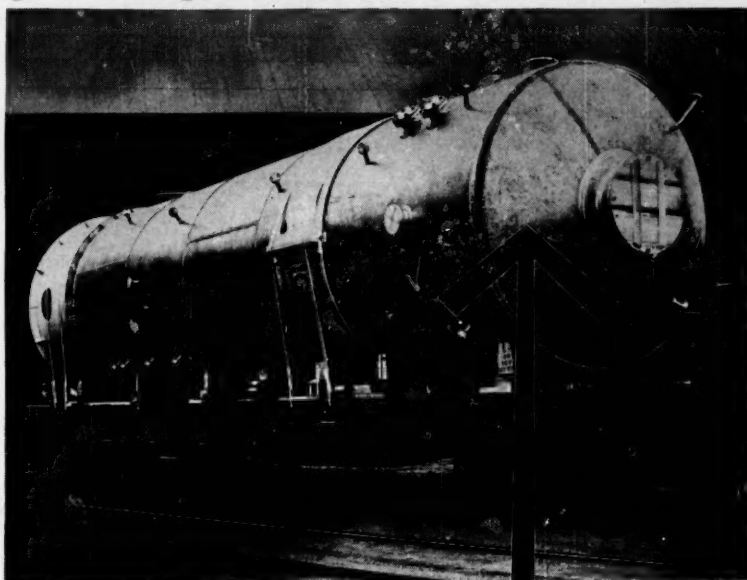
The first four chapters include material on basic types of servomechanisms, electrical data transmission, and analog computers. Next come eight chapters on the dynamic properties of electrical machines, vacuum tube amplifiers, and other component parts of servo systems. A brief treatment of non-linearity is included.

Seven chapters are devoted to mathematics of linear system analysis. Transient response and steady-state frequency response are discussed, using root-locus, Nyquist, and Bode methods. Since so much ground is covered here, many of the chapters are somewhat sketchy.

The author further gives an ex-

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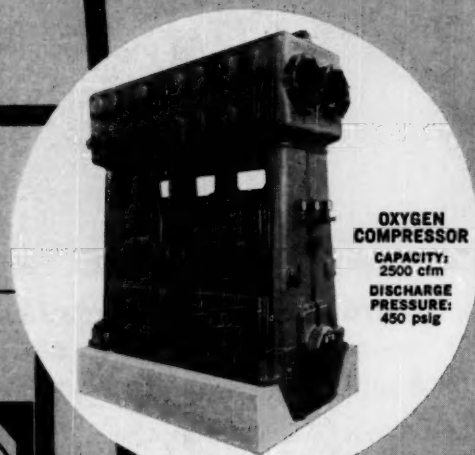
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#### BOOKSHELF . . .

tensive bibliography for additional study, and approximately 120 problems are included, with unusually full answers.

The book has two drawbacks for the chemical engineer who is beginning to study process control. First, as in other classical servo books, electrical examples are used throughout. Second, the chapters that are of immediate interest to the process engineer—those on transient and frequency response analysis—are too brief to be of much help. I would rather recommend starting out with one of the basic nonelectrical textbooks on process control, and then studying a more comprehensive treatise on control theory.

For the advanced engineer who has a good electrical background, however, this book would be a reasonable reference handbook.

#### TEXTILE TESTER

**HANDBOOK OF TEXTILE TESTING AND QUALITY CONTROL.** By E. B. GROVER AND D. S. HAMBY. TEXTILE BOOK PUBLISHERS, NEW YORK. 614 PAGES. \$17.50.

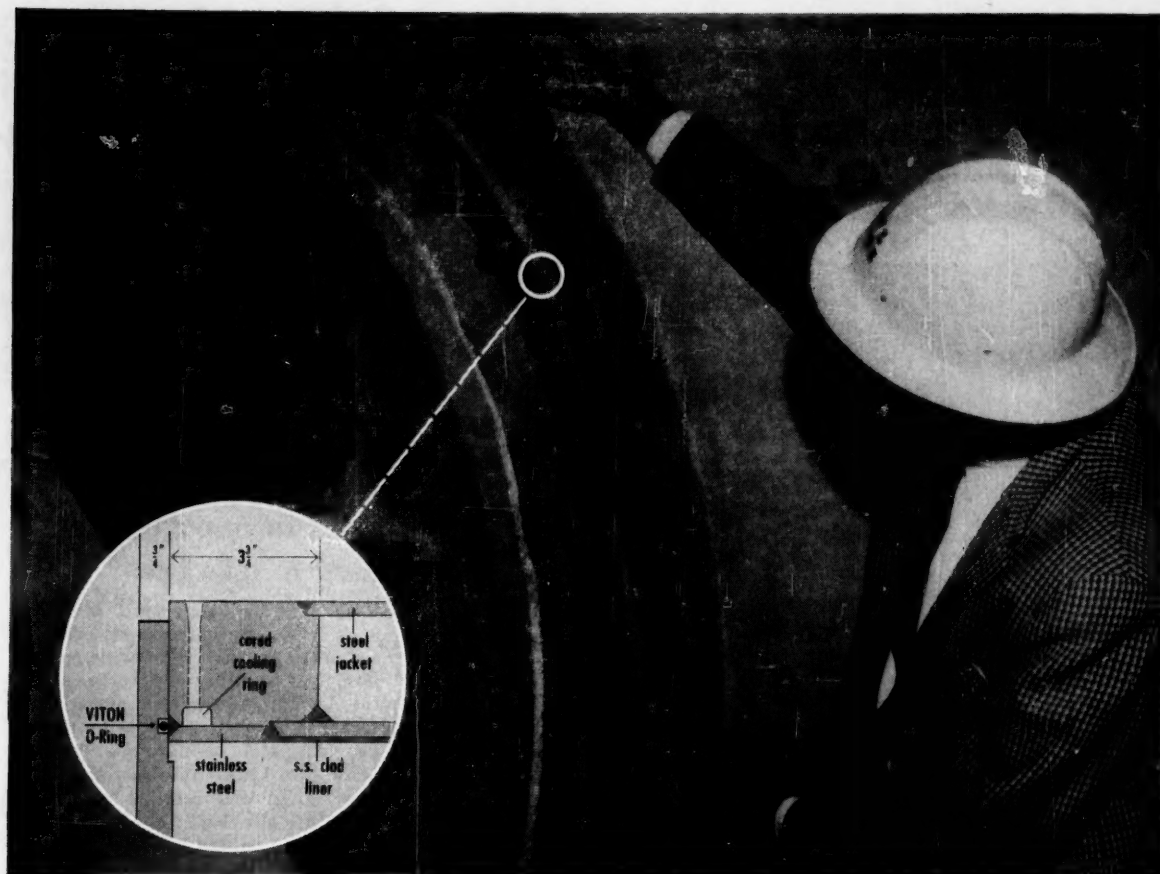
*Reviewed by C. W. Hammond, E. I. du Pont de Nemours, Textile Fibers Dept., Kinston, N. C.*

Written by two very well qualified authors, this comprehensive handbook on textile testing should serve as a useful reference for both old and new mill laboratories.

The subjects of testing instruments and methods are exhaustively covered for all phases of cotton and synthetic production up through weaving. Many useful correlations are given or suggested between test data and machine performance. The section on fabric tests is less thoroughly treated, but gives adequate testing methods for dimensions, count, strength, and physical defects.

Wool is very lightly discussed as a raw material to be tested and it is only by inference that one deduces that many of the processing tests are applicable to wool processes. The section on statistics and analysis of data is not nearly as well or clearly written as the other sections, and contains a number of errors and misstatements.





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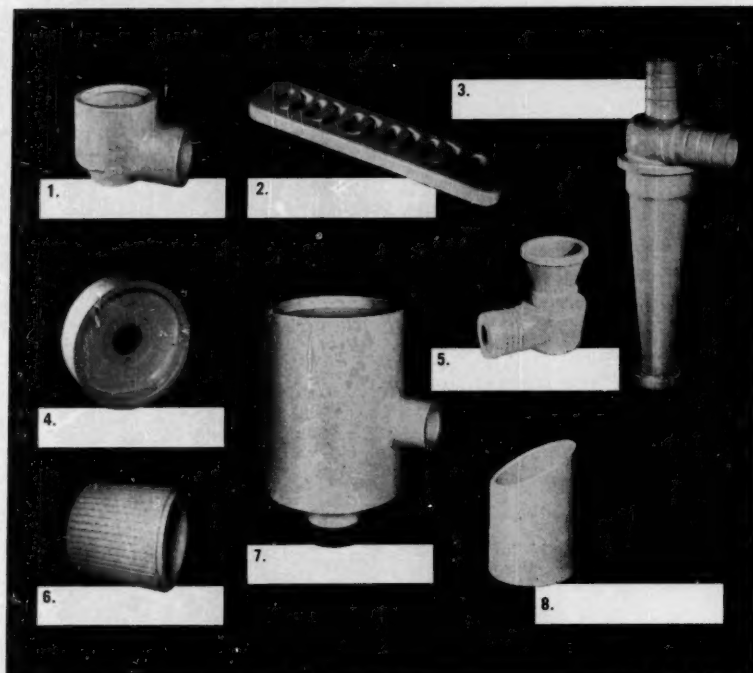


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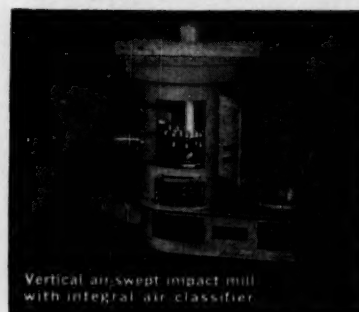
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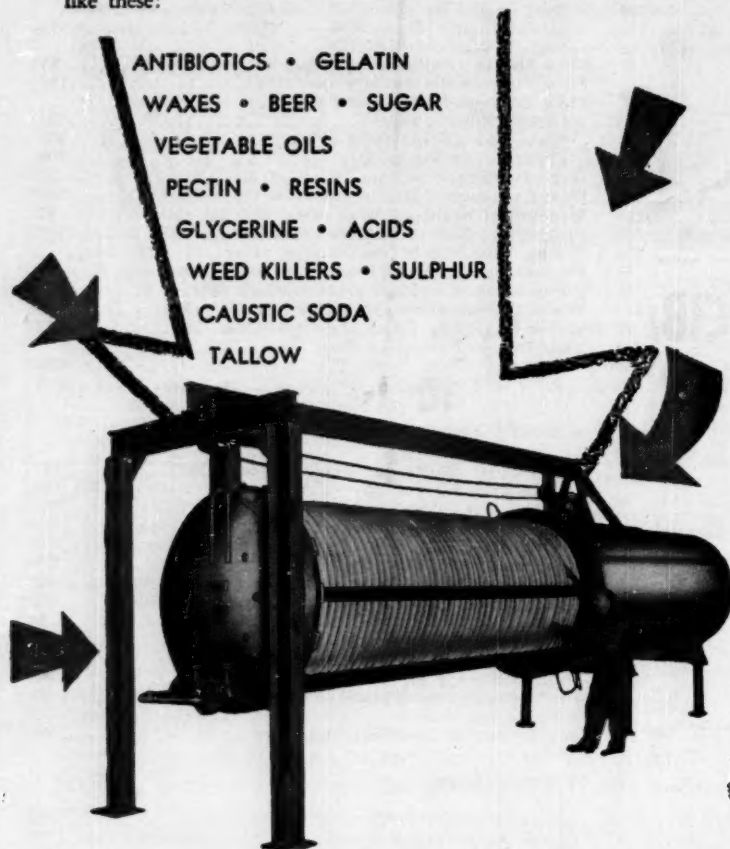
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\* Don't forget to check the Free Reprint box for your extra copy of this issue's reprint feature (p. 117)



# Steady filtration FULLY AUTOMATED

NIAGARA Filters are available in completely automated models for production-line filtration. Operating with process streams from 5 to over 1,000 gallons per minute, these highly efficient, versatile filters adapt easily to automatic processing of many materials like these:



Speedy cake removal, elimination of manual cloth washing and totally enclosed construction are NIAGARA advantages which are helping save time and improve product quality in all areas of the processing industry. For more complete data, see NIAGARA's section in Chemical Engineering Catalog or write Dept. CEN-661.

## Niagara®

NIAGARA FILTERS DIVISION OF  
**American Machine and Metals, Inc.**  
EAST MOLINE, ILLINOIS

*Specialists in Liquid-Solids Separation*

(Niagara Filters Europe: Kwakelpad 28, Alkmaar, Holland)

Divisions of American Machine and Metals, Inc.

TEXTILE LAUNDRY MACHINERY • RIEHLE TESTING MACHINES • DEWETHEAT PANS • TOLHURST CENTRIFUGALS  
FILTRATION ENGINEERS • FILTRATION FABRICS • NIAGARA FILTERS • UNITED STATES GAUGES • AUTOGAS  
AUTOMATIC DEVICES • LAMB ELECTRIC COMPANY • HUNTER SPRING COMPANY • GLASER-STEERS CORPORATION

## Manufacturers' Literature

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Pipe, fittings, valves ....	200
Process Equipment .....	201
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### Chemicals

**Additive.....**Paranox 221, a new detergent-inhibitor package, is a potent additive for formulating Series 3 oils. A comprehensive new bulletin is available.  
6 \*Enjay Chemical Co.

**Alkyl Amines.....**Complete property, shipping, handling and storage information on alkyl amines or any nitrogen compounds is available on request.  
73 \*Union Carbide Chemicals Co.

**Benzene.....**Production has been increased to meet your rising needs. Capacity now exceeds 80 million gallons. Full facts on benzene are available on request.  
85 \*Shell Oil Company

**Carbon Dioxide.....**Around the clock service for delivery of carbon dioxide in any form or in any quantity. An informative booklet is available.  
168 \*Olin Mathieson

**Catalog.....**Organic intermediates catalog gives information on properties, specifications and use of regular commercial products and lists many development products.  
188A Kay-Fries Chemicals Inc.

**Catalysts.....**Facilities are available for making carload quantities of performed catalysts to fit special requirements. "Harshaw Catalysts" booklet is offered.  
103 \*The Harshaw Chemical Co.

**Chemicals.....**A reliable source of supply for high purity naphthalene and benzene as well as such chemicals as toluene, xylene & heavy aromatic concentrates.  
69 \*Ashland Oil & Refin. Co.

**Hexachlorocyclopentadiene . . .**Bulletin 65 gives physical properties and reactions of chemical whose end products include nonflammable resins and chemical intermediates.  
188B Hooker Chemical Corp.

\* From advertisement, this issue

**Hydrofluoric Acid.....**Multiple facilities for anhydrous and aqueous Hydrofluoric Acid. Information and prices are available on this product on request.

57 \*General Chem. Div., Allied Chem.

**Methanol.....**offers lower raw material costs in the fact of rising prices for other alcohols. Product Bulletin S-03-6 is available on request for details.

147 \*Celanese Chemical Co.

**Plastic.....**Rulon's plastic memory means tighter seals at lower cost. Rulon parts are ideal for seals, packings, rings, etc. Brochure #9572 is offered.

L199 \*Dixon Corp.

**Polypropylene.....**The versatility and broad market potentials of polypropylene are underscored in a report in which the properties of the material are presented.

189A Eastman Chemical Products

**Porcelains.....**Custom made Chemical Porcelain used where acid and abrasion-resistant surfaces are needed. Description and specifications are available.

L184 \*Lapp Insulator Co., Inc.

**Sodium Chlorate.....**is 99½% pure. Available in the form of white crystals. It is very soluble in water and is a strong oxidizing agent.

93c \*Hooker Chemical Corp.

**Sodium Sulphydrate.....**This sodium sulphydrate assays 70-72% with water of crystallization at 18 to 26%. Further information is available on request.

93b \*Hooker Chemical Corp.

**Sodium Sulfide.....**put up in small flakes so you get a faster dissolving action, even in cold water. Further information on this chemical is available.

93a \*Hooker Chemical Corp.

**Solvents.....**Folder "Amsco Solvents" presents product specifications in comparative form and includes distillation ranges and relative time of evaporation.

189B American Mineral Spirits Co.

Want to build up your files and keep them up-to-date? You can get any publication in this comprehensive guide — free — just for the asking.

It's easy — simply circle item's number on the Reader Service Postcard and mail. Replies will come directly from companies offering the literature.



ONE OF 6 BATCH-MASTER CENTRIFUGALS AT CIBA PHARMACEUTICAL PRODUCTS, INC., SUMMIT, NEW JERSEY

## CIBA unloads BATCH-MASTER® with 1/30th the labor required by previous equipment

Manual unloading of extremely hard filter cake posed an especially difficult problem in the synthesis of Pyribenzamine\*. A TOLHURST BATCH-MASTER CENTRIFUGAL with fast bottom discharge and hydraulic unloading cut the unloading labor to 1/30th of what it was formerly.

### Today — More Batch-Masters

The cost-saving success of the first BATCH-MASTER has led to the installation of additional units. Presently, three 40" models and three 48" units serve varied uses in separating solids from slurries.

TOLHURST BATCH-MASTER CENTRIFUGALS combine rapid bottom unloading with inherent stability of patented Center-Slung® suspension. A completely automated control system speeds processing and assures product uniformity. Write today for free bulletin.

\*REGISTERED TRADEMARK OF CIBA PHARMACEUTICAL PRODUCTS, INC.

# Tolhurst®

### TOLHURST CENTRIFUGALS DIVISION

American Machine and Metals, Inc., Dept. CET-661, East Moline, Illinois

Please send me free illustrated bulletin on TOLHURST BATCH-MASTER CENTRIFUGALS with labor-saving bottom discharge.

NAME AND TITLE

COMPANY

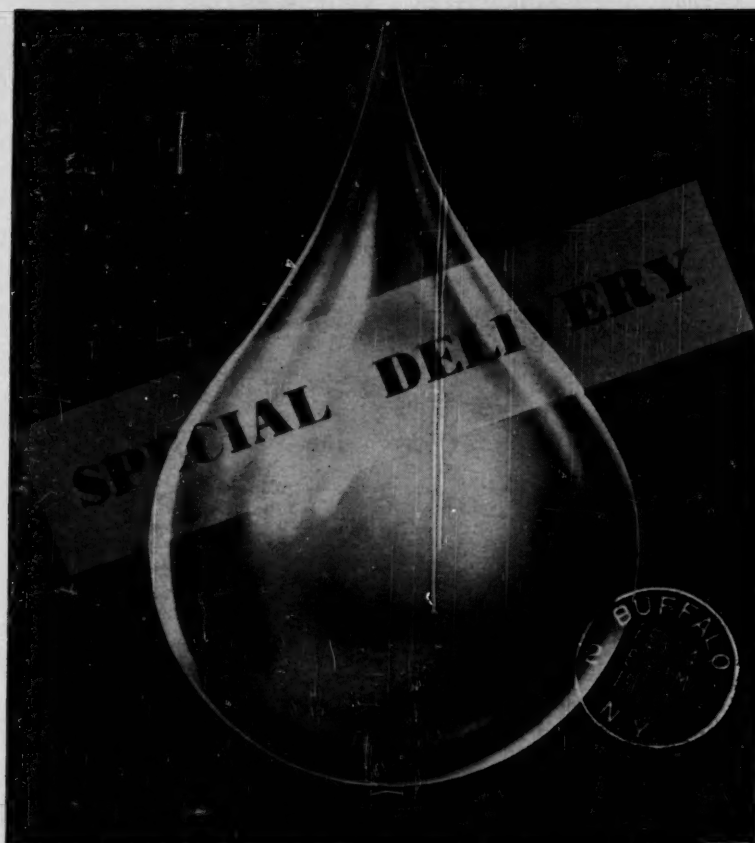
ADDRESS

CITY & ZONE

STATE

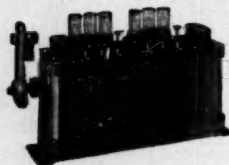
TROY LAUNDRY MACHINERY • DIVISIONS OF AMERICAN MACHINES AND METALS, INC.  
FILTATION ENGINEERS • FILTATION FABRICS • NIAGARA FILTERS • UNITED STATES GAUGE • AUTOSAR  
AUTOMATIC DEVICES • LAMB ELECTRIC COMPANY • HUNTER SPRING COMPANY • GLASER-STEERS CORPORATION

# HOW FAST should you



## deliver a drop of oil?

Whether you're operating high-compression diesels or fast-moving shear knives, you're probably paying more and more attention to lubrication *timing*. Whatever your field, our engineers will be glad to study your requirements and make specific recommendations. Your needs can be met either by adapting an existing model—or we will custom-build you your own lubricating system. Write for our catalog. Manzel, 250 Babcock Street, Buffalo 10, New York. You will get exact, on-time lubrication if you



ask the man from



SPECIALISTS IN LUBRICATORS AND METERING PUMPS

# Manzel

SINCE 1898

### LITERATURE . . .

**Solvents.....**A monograph is offered telling how to set up 31 tests and how to run them and how they can help improve your current formulations.

52

\*Shell Chemical Co.

**Thionyl Chloride.....**can be used in organic synthesis to replace with chlorine various groups such as OH, SH, SO<sub>2</sub>, H or O. Further information is offered.

93d

\*Hooker Chemical Corp.

**White Oil.....**Research bulletin reviews applications of white mineral oils and fully refined hydrocarbon distillates in the manufacture of various plastics.

190A

Sonneborn Chemical & Refining Corp.

### Construction Materials

**Alloys.....**Nine corrosion-resistant alloys are available to solve corrosion problems. Test samples and descriptive literature are available on request.

155

\*Haynes Stellite Co.

**Butyl Rubber.....**Now you can get Butyl rubber in convenient latex form, an emulsion that has all the outstanding properties of Butyl. A Latex Manual is offered.

139

\*Enjay Chemical Co.

**Casting Alloy.....**"HOM" is a special high nickel alloy developed to produce castings that meet high temperature requirements. Additional information.

201

\*The Duraloy Co.

**Coating.....**No matter what the size or shapes of your product, it can be coated better with Kanigen nickel alloy. Detailed information in Bulletin 561.

77 \*General American Transportation

**Coatings.....**Kel-F dispersion coatings resist sticking and resist chemicals. May be applied to most metals that can stand approximately 500 deg. F. Tech. data.

90

\*Minn. Mining & Mfg. Co.

**Coatings & Enamels....**Imlar vinyl-mastic coatings & vinyl enamels have been developed for use where metal protective finishes are not recommended. Bulletin.

35a

\*E. I. DuPont de Nemours

**Construction Material.....**Koroseal PVC won't corrode, can't rust, is easy to fabricate and install. A catalog is available describing its many advantages.

1

\*B. F. Goodrich

**Epoxy Enamels.....**Corlar epoxy chemical-resistant enamels have been developed for surfaces subject to severe corrosive conditions. Technical bulletin in offered.

35b

\*E. I. DuPont de Nemours

**Fabrication.....**Sheet metal and alloy components, weldments and plate work, custom fabricated. A 40 page catalog on fabrication is available on request.

198

\*Kirk & Blum Mfg. Co.

**Gaskets, Teflon-Jacketed.....**Wide variations of styles, filler materials and sizes can be furnished to suit practically all process equipment. Cat. AD-154.

157

\*Garlock, Ind.

\* From advertisement, this issue



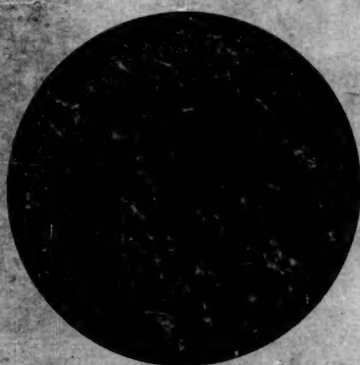
# IT'S THE INTERLOCK THAT MAKES MONO-BLOCK®

It's no wonder that hundreds of industries' leaders specify Baldwin-Ehret-Hill Mono-Block for their medium and high temperature block insulation requirements, up to 1800 F.

The reason? An exclusive Baldwin-Ehret-Hill manufacturing process assures that the fine mineral wool fibers used in Mono-Block are completely and thoroughly dispersed in a liquid slurry and thereby interlocked to provide the highest strength. Further, this interlocking process means that Mono-Block will cut cleanly and conform to irregular surfaces, such as lap or butt welds, etc., without tearing or breaking.

Another reason for Mono-Block's leadership is its high strength, minimizing loss due to breakage. And the tough, strong surface of Mono-Block can be directly finished with Baldwin-Ehret-Hill No. 1 or Super Powerhouse Cements in many instances without the need for applying wire mesh.

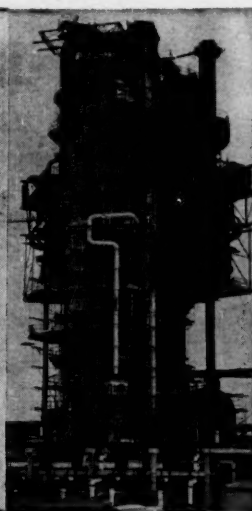
For detailed information about Mono-Block or any of the complete line of industrial insulations manufactured by Baldwin-Ehret-Hill, and the name of your nearby B-E-H qualified contractor, write to Department M-B, Baldwin-Ehret-Hill, Inc., 500 Breunig Ave., Trenton 2, N. J.



B-E-H Mono-Block magnified 10 times to show uniform, interlaced structure resulting from interlocked fibers.



A commercially available block product equally magnified to show the uneven texture.



Mono-Block insulates the world's largest catalytic cracking unit for Tidewater in Delaware.

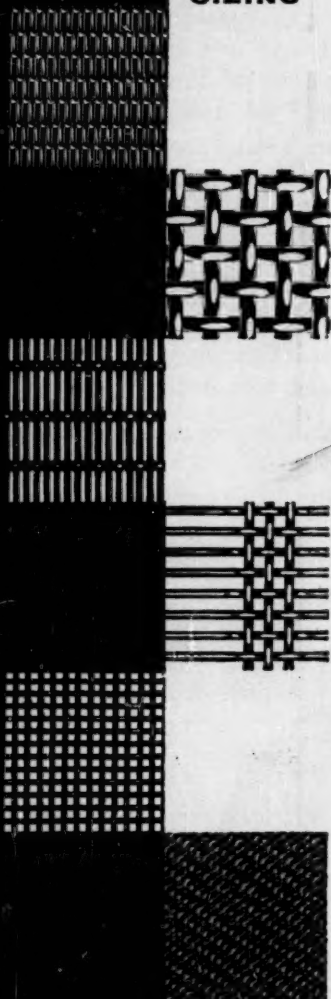


Baldwin-Ehret-Hill manufactures a complete line of mineral fiber, calcium silicate, 85% magnesia and polyurethane industrial insulation products, including pipe insulation, blocks, blankets, felts, cements and loose fill for sub-zero to 1900 F service.

**BALDWIN-EHRET-HILL, INC.**  
Trenton New Jersey



**MORE EFFICIENT,  
LOWER COST  
FILTERING, STRAINING,  
SIZING**



The industry's highest quality – wire cloth and screen precisely engineered and precision woven to achieve the most critical predetermined results... to provide greater resistance to corrosion, pressure, vibration, heat or abrasion... to assure improved product quality and uniformity, increased production, lower costs... or to help solve other problems involved in your filtering, separation or straining operation.

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L.S. and Star Cloth and Screens are woven from any steel including high carbon, oil-tempered, stainless and other alloys, Monel, bronze, copper, brass or any metal that can be drawn into wire.

WRITE FOR  
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SCREEN REFERENCE  
CATALOG

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**Ludlow-Saylor**



**WIRE CLOTH & SCREENS**

**LUDLOW-SAYLOR WIRE CLOTH COMPANY**  
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Birmingham 512 North 18th St. Pittsburgh Union Trust Bldg.  
Chicago 6261 W. Grand Ave. Houston 5638 Harvey Wilson Dr.  
Denver 1530 Carr St.

**STAR WIRE SCREEN & IRON WORKS**  
Sunset Ave. & Valley Blvd., City of Industry (L.A. County), Calif.

**LITERATURE . . .**

**Industrial Insulation . . . . .** Mono-Block insulation is high in strength & minimizes loss due to breakage. Detailed information on Mono-Block is available.  
191 \*Baldwin-Ehret-Hill, Inc.

**Insulation . . . . .** Foamglas insulation is completely waterproof and is incombustible. Solves insulation problems above or below ground, indoors or outdoors. Data Sheets.  
160 \*Pittsburgh Corning Corp.

**Lead Products . . . . .** These products include chemical lead sheets to your requirements; pipe, bends, traps & standard fittings. Bul. 162, the Lead Handbook for the CPI.  
43 \*American Smelting & Refining

**Plastic Fabrications . . . . .** Even the largest corrosion problems are routine with reinforced plastic construction. Bulletin 103 is available for details.  
215 \*DuVerre, Inc.

**Refractory, Silicon Carbide . . . . .** Crystolon "63" has high thermal conductivity, excellent heat shock and wear resistance, and good resistance to most corrosive liquids. Information.  
87 \*Norton Co., Refractories Div.

**Sintered Titanium . . . . .** 4-page bulletin pinpoints cost-saving potentials of sintered titanium in modern design and includes tolerances, and processing and specifying data.  
192A Clevite Corp.

**Stainless Steel . . . . .** New booklet "Producing Stainless Steels" is fully illustrated. It includes detailed sections on stainless steel plates, heads, forgings, etc.  
48 \*G. O. Carlson, Inc.

**Synthetic Rubber . . . . .** A booklet that contains technical data about Viton synthetic rubber and its many applications is available on request.  
183 \*E. I. DuPont de Nemours

**Wire Cloth & Screen . . . . .** woven from any steel including high-carbon, oil-tempered, stainless & other alloys. Condensed Screen Reference catalog is offered.  
192 \*Ludlow-Saylor

**Electrical & Mechanical**

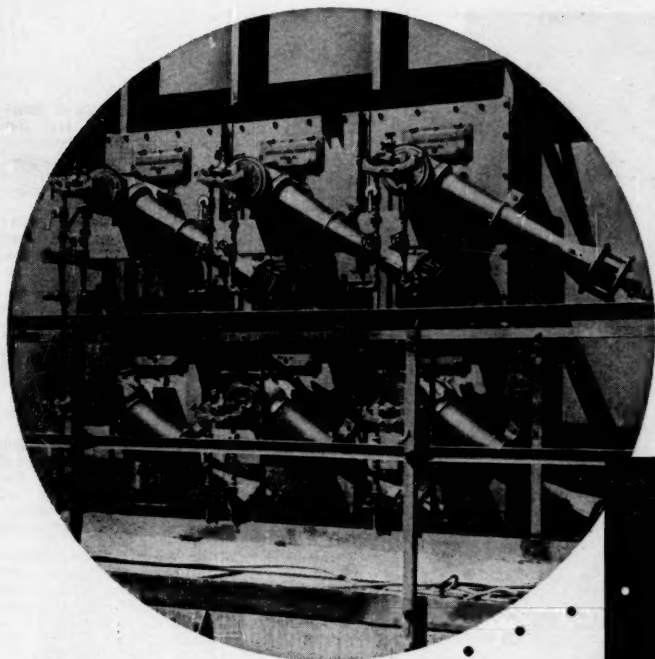
**Cable . . . . .** MI cable is ideally suited for all types of trouble areas. The many unique characteristics of this versatile cable construction in the new MI catalog.  
167 \*General Cable Corp.

**Couplings . . . . .** for every operation that calls for quick, tight connections. Available in brass, malleable, stainless aluminum, etc. Details in illustrated Catalog C-11.  
149 \*Ever-Tite Coupling Co., Inc.

**Expansion Joints . . . . .** AMR expansion joints handle even the highest surge pressures safely. Full facts of this revolutionary development are available.  
135 \*U. S. Rubber Co.

**Motor Protection . . . . .** Everseal resin-encapsulated windings are completely protected against severe environments. Everseal literature is available on request.  
219 \*U. S. Electrical Motors, Inc.

\* From advertisement, this issue



## NATIONAL AIROIL OIL-GAS TANDEM COMBUSTION UNITS

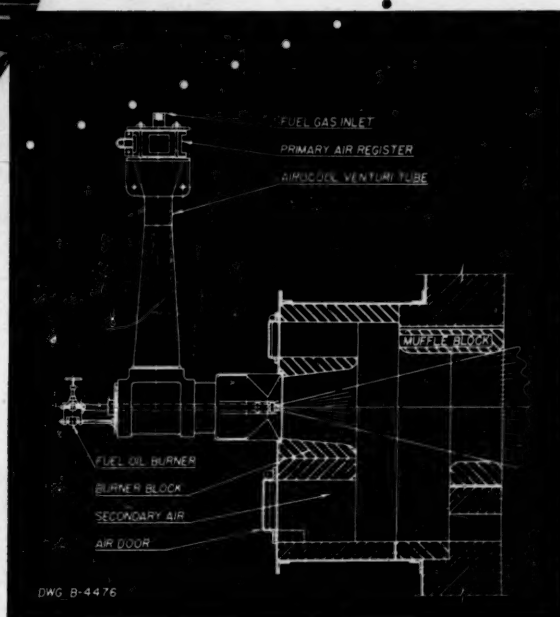
### Fire World's Highest Thruput Crude Distillation Unit

At Tidewater Oil Company's modern Delaware Refinery, this huge crude furnace now has the world's record capacity of 150,000 barrels per day. It is equipped with National Airoil Burner Company's exclusive Tandem Block Combustion Units... easily capable of exceeding the designed capacity of the furnace when burning either liquid or gaseous fuels.

These Tandem Units will burn up to high viscosity residuum oils and/or varying molecular weights of refinery gases. They have

high individual heat liberating capacity as well as turn down ratio on natural draft thus avoiding the cost of a blower system. They will operate with low excess air.

Because these high combustion efficiency Tandem Units liberate a large proportion of heat by flame radiation to the heat absorbing surfaces, they increase the days on stream by reducing flame impingement with its accompanying high maintenance cost to tubes, brick work, etc.



Established 1912  
Incorporated 1917

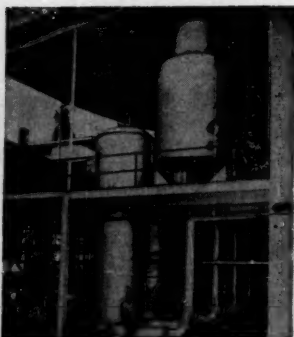
**NATIONAL AIROIL BURNER COMPANY, INC.**

1284 E. Sedgley Avenue • Philadelphia 34, Pa., U.S.A.

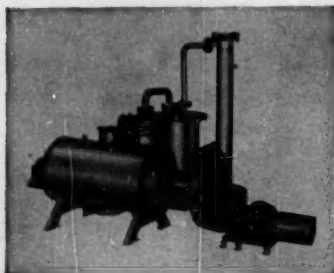
*Industrial Oil Burners, Gas Burners and Combustion Equipment*

# G-B

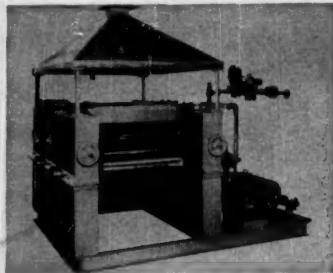
## HEAT TRANSFER EQUIPMENT



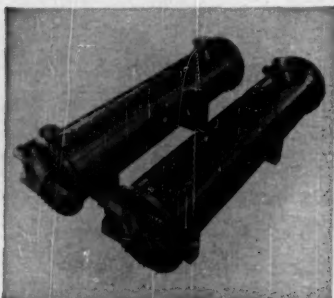
▲ EVAPORATOR — All stainless steel quadruple effect.



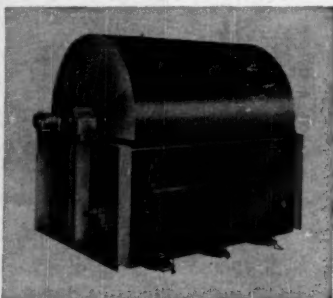
▲ VACUUM ROTARY DRYER — Designed for efficient removal of moisture at low temperatures.



▲ DRUM DRYERS—Available with a variety of feed arrangements.



▲ HEAT EXCHANGERS — Special design with high alloy and multipass liquor flow.



▲ FLAKERS—Rapid and continuous operation. Diameter sizes from 18" to 60". Lengths to suit requirements.

Goslin-Birmingham process equipment is custom designed to meet your specific requirements.

Write for more detailed information

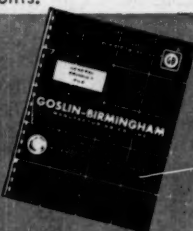


**GOSLIN-BIRMINGHAM**  
MANUFACTURING CO., INC.

P.O. BOX 531 • BIRMINGHAM, ALABAMA

FILTERS • EVAPORATORS • DRYERS • FLAKERS

CONTRACT MANUFACTURING including HEAVY CASTINGS



## LITERATURE . . .

**Motor Starters**.....A new line of Bulletin 709 motor starters are the greatest advance in motor control in thirty years. More information is available.  
47 \*Allen-Bradley

**Motors**.....Guardistor motors are engineered to give top performance in a wide range of applications. Additional information is contained in booklet B-7876-A.  
22-23 \*Westinghouse Electric Corp.

**Motors**.....16-page bulletin "1961 Motor Application Guide" describes line of single phase, three phase and direct current motors and include motor selection chart.  
194A Century Electric Co.

**Packing Rings**.....are precision made to always give you a perfect seal —no matter how difficult the special sealing requirements of your application. Information.  
59 \*C. Lee Cook

**Pumps, Motors, Drives**.....Comprehensive technical and descriptive 20-page brochure contains data to expedite the selection of the optimum motor or drive.  
194B U. S. Electrical Motors Inc.

**Starters**.....These high voltage starters are designed for easier installation, inspection and maintenance. Descriptive literature in Bulletin 8131-T.  
79 \*Square D Company

**Thermocouples**.....Ceramo thermocouples can bend to almost any configuration. More than 48 pages of profitable information on every type fill Catalog TC-4.  
202 \*Thermo Electric Co., Inc.

**Thermocouple Components**.....Wires, insulators, protecting tubes, heads, blocks, connectors & miscellaneous components. Catalog G100-3 is available.  
L218 \*Minneapolis-Honeywell

## Handling & Packaging

**Conveying Line Diverter**.....Specification sheet describes diverter said to increase efficiency and reduce cost of diverting a stream of powdered and granular materials.  
194C Flo-Tronics Inc.

**Conveyors, Airstream**.....A new 32 page brochure presents detailed information on how these conveyors solve bulk materials handling problems. Bulletin 530.  
34 \*Dracoco, Div. of Fuller Co.

**Idler**.....New 44-page Idler bulletin describes the more than 800 units available in the complete line. Covers all features. Copy will be sent on request.  
12-13 \*Barber-Greene

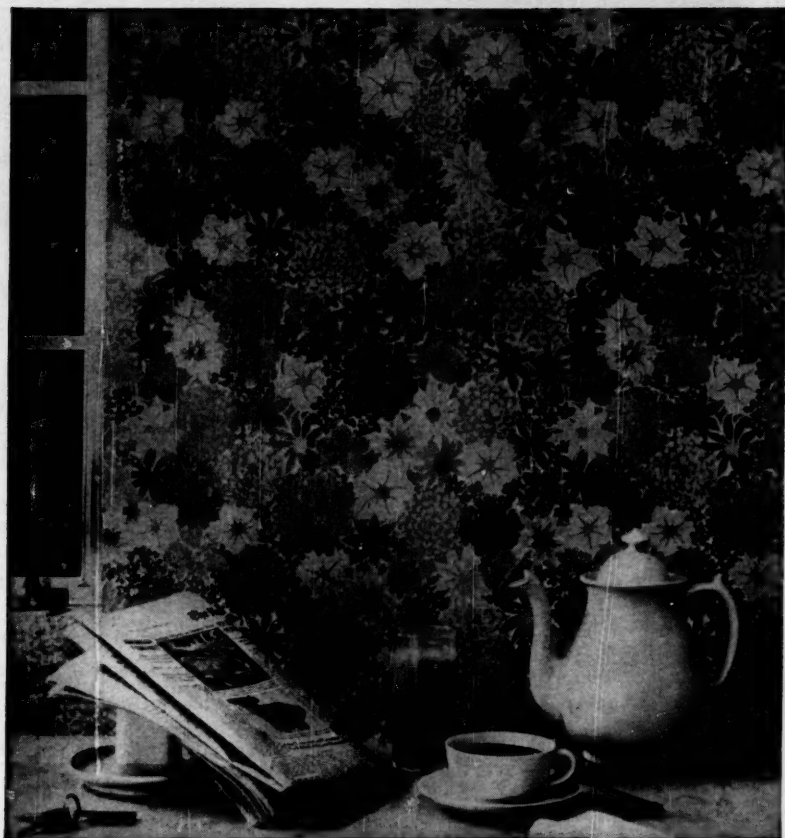
**Lift Truck Attachments**.....put the "hand" in "handling". A full line of easy-to-mount attachments makes the A-C list trucks almost as flexible as your own two hands.  
96 \*Allis-Chalmers

**Materials Handling**.....Portable Airveyor transfer units convey pelletized or granulated materials with high efficiency. Full details in Bulletin A-23.  
176 \*Fuller Company

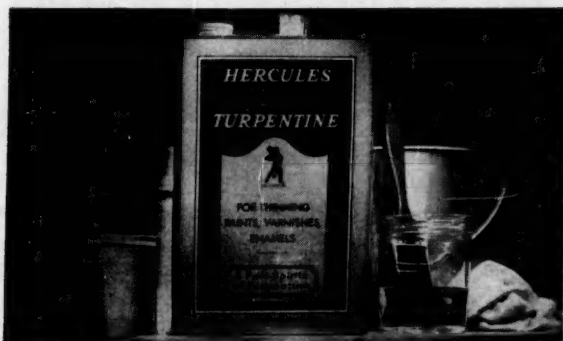
\* From advertisement, this issue



# HOW *HERCULES* HELPS...



**BRIGHTEN UP WALLS**—Recently introduced nationally, Imperial® Fabric Wallcovering offers many new and exciting ideas in economical home decorating. Styled by John and Earline Brice, famous designers of home furnishings, it introduces new, sun-splashed colors . . . new, graceful designs . . . guaranteed colorfast washability. Easy to hang and easy to remove, it's the lowest priced fabric wallcovering made. Imperial dealers now feature it, from coast to coast.



**SOLVE PAINT PROBLEMS**—Hercules® steam-distilled wood turpentine assures a better job when thinning oil-base paints, varnishes, and enamels because it keys the paint to the surface, makes it less liable to crack or scale, and helps distribute the finish evenly. That's why so many professional painters rely on this familiar orange-and-black can.



**IMPROVE INSULATION**—Where insulation problems require a new approach, Pro-fax® polypropylene often provides the answer. This new plastic has properties unmatched by other insulating materials, as demonstrated by the communication cable shown here, where a 3-mil coating of Pro-fax meets every construction requirement.

## HERCULES

**HERCULES POWDER COMPANY**

INCORPORATED

Hercules Tower, 910 Market Street, Wilmington 99, Delaware

**CHEMICAL MATERIALS FOR INDUSTRY**



GGI-S

195





## NEW TEST CENTER

for  
PROVING  
and  
IMPROVING  
EJECTORS

FIVE-STAGE EVACUATOR AND BOOSTER



You are cordially invited to visit this new building devoted entirely to testing, development and research. Here you will see facilities as modern and complete as any existing for the testing of steam jet vacuum equipment.

Floor space and test blocks are sufficient to permit the simultaneous testing of a variety of equipment along with special testing of vacuum processing under actual operating conditions. To assist, we have a steam generating plant equipped with two boilers: one of capacity up to 25,000# per hour at 250# ga; the other, 4,000# per hour at 600# ga. Also: a 60,000-gallon cooling pond and assorted liquid pumps up to 3,000 gpm for both positive pressure and vacuum service; a 4,000 square foot surface condenser; a 6-ton hoist.

Under the same roof for use in research are other types of heavy equipment and laboratory instruments of most accurate design. All together, the facilities of our testing and research center give extra assurance that jet vacuum equipment, fume scrubbers and cooling units from Croll-Reynolds will perform exactly as specified.



# Croll-Reynolds CO., INC.

Main Office: 751 Central Avenue, Westfield, N. J.

Chill-FACTORS® • Steam-Jet EVACTORS® • Aqua-FACTORS® • Fume Scrubbers • Special Jet Apparatus

## LITERATURE . . .

**Payloader.**...Model H-30 is the smallest 4-wheel-drive Payloader but has an operating capacity of 3,000 lbs. and the features of larger models. Data is offered.  
153 \*The Frank G. Hough Co.

**Refuse Collection.**.....Super Dumpster no-container-haul system can be used with Dumpster containers. A free brochure gives further information.  
38 \*Dempster Brothers

**Tanks.**.....Applications of Poxyglass corrosion-resistant tanks, features of the glass-resin material and a discussion of the manufacturing method are included in bulletin.  
196A Black, Sivalls & Bryson, Inc.

## Heating & Cooling

**Centrifugal Refrigeration.**.....can be used with any type of drive, electric motor, steam or gas turbine, diesel or gas engine. The machines versatility is unlimited.  
99 \*Carrier Air Conditioning Co.

**Combustion Units.**.....Combination oil and gas tandem combustion units offer better service and improved performance. Max. of heat transfer with high turn-down ratio.  
193 \*National Airoil Burner Co.

**Evaporator.**....constructed with stainless steel and Hortonclad stainless on areas subject to corrosion and embodying high standards of fabrication for less maintenance.  
41 \*Chicago Bridge & Iron Co.

**Furnaces.**.....Box type furnaces to solve heating problems for chemical processing, drying and activating. Details are contained in Bulletin 75-TD.  
TL205 \*Trent, Inc.

**Heat Exchange.**.....is no problem with a Holo-Flite processor and a Hi-Turbiant heater. Literature is available for details on this efficient team.  
145 \*Western Precipitation

**Heat Exchangers.**.....return 30% on investment. An important study, "New Economies in Cooling Chlorine" is available and may be had upon request.  
26-27 \*Titanium Metals Corp.

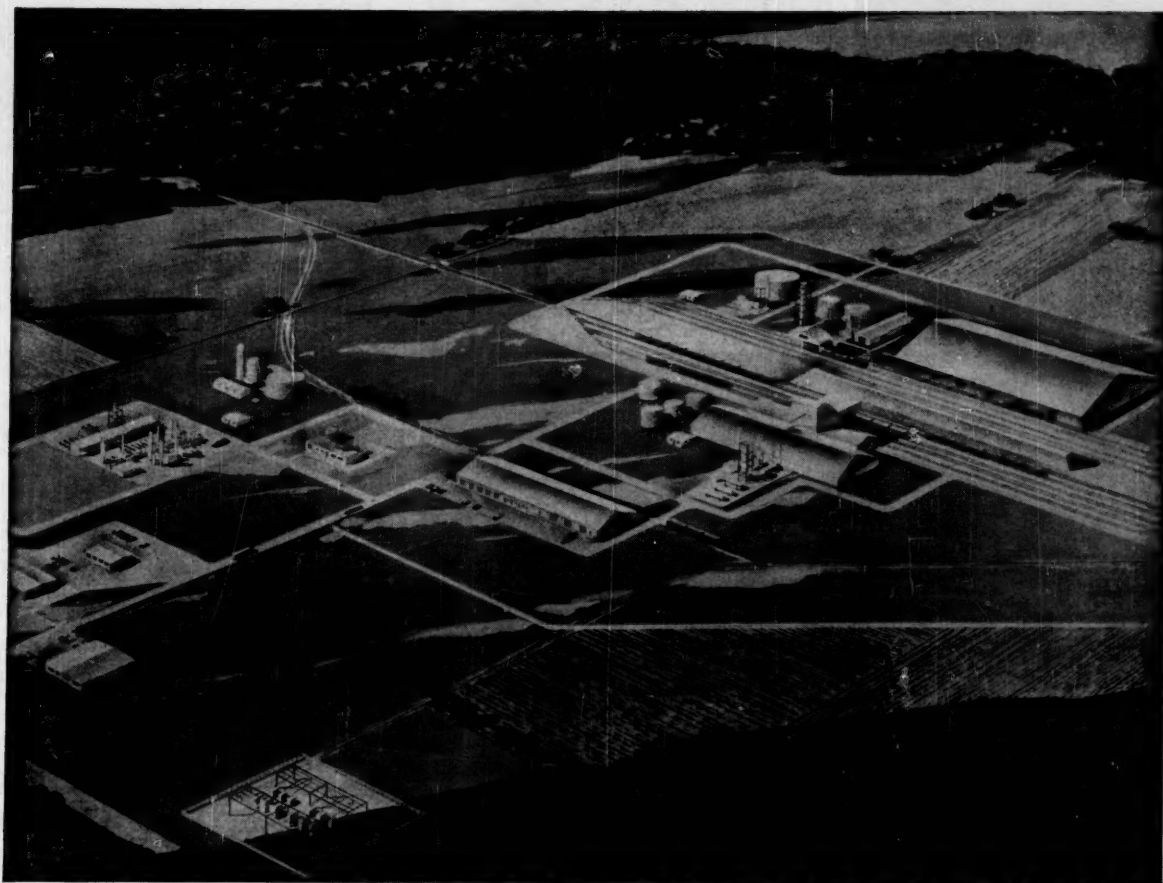
**Heat Exchangers.**.....Brazed Aluminum surface consists of corrugated aluminum sheets brazed together to form a stack of layers that provide individual passages. Facts.  
10-11 \*Trane Co.

**Heat Transfer Equipment.**.....is custom designed to meet your specific requirements. An informative booklet is available for details on the complete line.  
194 \*Goslin-Birmingham Mfg. Co.

**Heaters.**.....Hi-Turbiant heaters heat direct-fired process streams & heating transfer fluids fast & economically. Literature may be had upon request.  
TL217 \*Western Precipitation

**Heating Mantles.**.....Safe, dependable electric heating mantles for every use. A bulletin is available for more detailed information and may be had upon request.  
88 \*Glas-Col Apparatus Company

\*From advertisement, this issue



*Architect's drawing of the multi-million-dollar nitrogen fertilizer manufacturing complex for Armour at Cherokee, Alabama.*

## Helping to Create the Cherokee Fertilizer Complex

The M. W. Kellogg Company has been given many assignments for the new multi-million-dollar nitrogen fertilizer manufacturing complex now being erected for Armour Agricultural Chemical Company at Cherokee, Alabama. Financed by the Town of Cherokee with a \$25 million bond issue, the project will be leased to and operated by Armour.

Kellogg is engineering, procuring materials for, and constructing the 360-ton/day ammonia plant and the 50-ton/day urea plant. It will also be responsible for construction of all offsites. These include: utility and gas systems, power house, water pumping station, effluent disposal system; administration, maintenance, product storage, and service buildings; tankage, intermediate piping, and equipment utilized in offsites. In addition, Kellogg has a contract for engineering-management of the entire project.

This huge new fertilizer complex, which comprises six different plants on a 1200-acre site, is part of a \$60 million expansion program currently being undertaken by Armour which will include a new phosphate plant to be erected near Fort Meade, Florida. When completed, in 1962, the chemical industries part of the Armour organization will represent more investment than the total for the meat producing facilities of the Chicago parent firm.

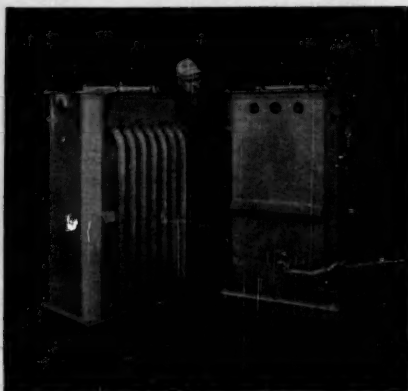
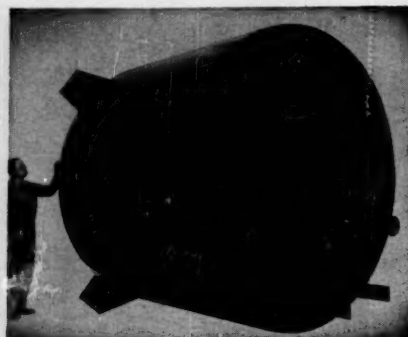
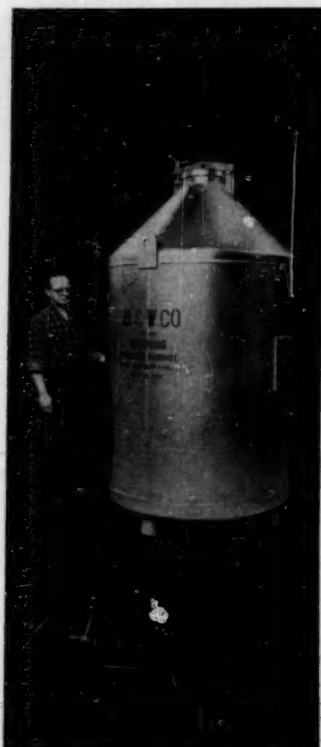
*For information on Kellogg's background in fertilizers, write:*

### THE M. W. KELLOGG COMPANY

711 Third Ave., New York 17. A subsidiary of Pullman Incorporated

The Canadian Kellogg Company, Ltd., Toronto  
Kellogg International Corporation, London  
Societe Kellogg, Paris  
Kellogg Pan American Corp., Buenos Aires  
Compania Kellogg de Venezuela, Caracas  
Companhia Kellogg Brasileira, Rio de Janeiro





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The Kirk & Blum Manufacturing Co.  
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Fabricated  
by*

# KIRK & BLUM

## LITERATURE . . .

**Steam Trap**..... Model N-150 thermostatic steam trap features all steel construction with just one working part. It is freeze-proof when installed vertically.  
204 \*W. H. Nicholson & Co.

**Steam Traps**..... have only two moving parts, the lever assembly & the bucket. The 44-page steam trap book discusses trap selection, installation and maintenance.  
37 \*Armstrong Machine Works

## Instruments & Controls

**Computer**.....Recomp 11 has exclusive built-in floating point arithmetic. Also features built-in square root command and automatic conversion from decimal to binary.  
49 \*Autonetic Div., N. Amer. Avia.

**Controller**.....CycleLog controller can be used to your advantage on your processes. Further details are contained in Bulletin 5A-12 which is offered.  
89 \*Foxboro Company

**Controller**.....The new Frac Controller adjusts column operation to the effects of ambient temp. on overhead product condenser & external reflux. Details.  
16-17 \*Minneapolis-Honeywell

**Detector**.....New Flamon detector can help you be sure the burner flame is on. Provides a wide temperature range, allows easy inspection and is of weatherproof construction.  
163 \*Bailey Meter Company

**Dial Thermometer**.....Both vapor tension and gas-filled types are available in either distant reading or rigid stem types. Catalog offered.  
T178 \*Marsh Instrument Co.

**Flow Meter**.....Bulletin 380.20-2 contains cutaway views, flow range tables, accuracy curves and typical applications of a propeller type, totalizing flow meter.  
198A B-I-F Industries

**Liquid Lever Control**.....is available for controlling level changes from 1/4" to 150 ft. Multi-stage switching when desired. Information on Magnetrol on request.  
TR214 \*Magnetrol, Inc.

**Pneumatic Transmitters**.....give you a true primary and transmitted signal for indication or control. Factful Bulletins 360 and 361 can help you in your selection.  
83 \*Manning, Maxwell & Moore, Inc.

**Pressure, Vacuum Gages**.....32-page catalog describes companies instruments for measuring, indicating, recording and controlling pressures and vacuums.  
198B Minneapolis-Honeywell Co.

**Pulsation Snubbers**.....are the most effective control measures available to eliminate pulse-induced vibration. Equipment performs better and operating costs are reduced.  
R199 \*Burgess-Manning Company

**Ratio Computer**.....VRC ratio computer replaces a conventional ratio device & two square root extracting mechanisms in the flow ratio pneumatic control system. Literature.  
172a \*Republic Flow Meters Co.

\* From advertisement, this issue

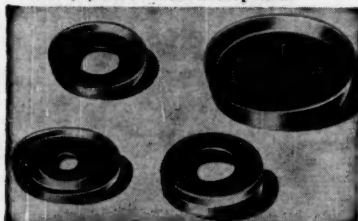


# RULON. TEFLON

## RULON — first practical fluorocarbon for cup packings

Dixon's new post-forming technique makes use of Rulon's plastic memory to insure tight seals under all conditions . . . at lower cost than ever before!

Packings of Rulon (filled TFE) give you: (1) low friction, (2) high resistance to wear, (3) low deformation under load ( $\frac{1}{2}$  that of Teflon\*), (4) wide temperature tolerance ( $-400^{\circ}$  to  $+500^{\circ}\text{F}$ ), (5) chemical inertness, (6) lube free operation, and (7) zero water absorption.

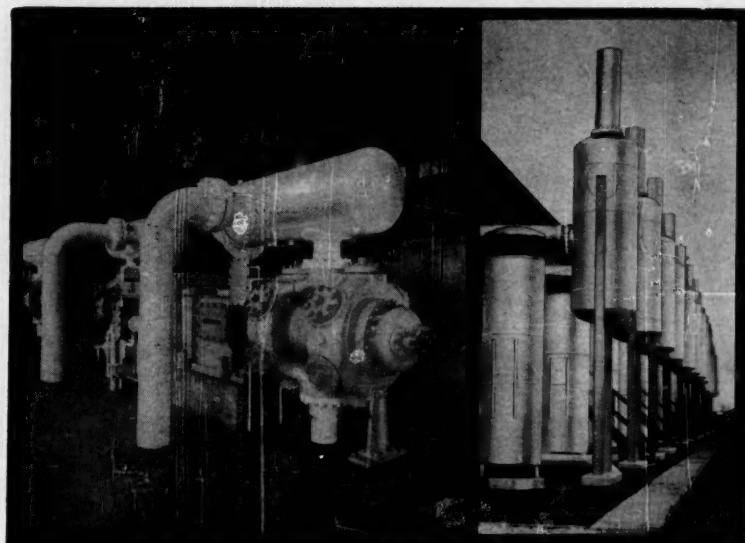


RULON now serves in pumps, valves, motors, compressors and scores of other products manufactured by leading companies across the nation. Dixon offers the widest variety of basic shapes, both in RULON and Teflon . . . plus engineering capability to formulate special reinforced fluorocarbons for special needs. Also, Dixon can supply molded, machined, stamped, cut or extruded parts to meet your print.

See our guide-book on RULON, Bulletin #9572, in Sweet's Product Design File or send details for recommendations. DIXON CORPORATION, 101 BURNSIDE ST., BRISTOL, R. I.

• DuPont T.M.

# DIXON




## ELIMINATE PULSATION AND NOISE WITH BURGESS-MANNING SNUBBERS

Burgess-Manning Pulsation Snubbers are the most effective control measures available to eliminate pulse-induced vibration. Equipment performs better, operating and maintenance costs are reduced, breakdowns, and repairs are fewer, and even structural damage to buildings and foundations is prevented. Similarly, when a Burgess-Manning Silencer is installed to eliminate excessive noise, employees work more efficiently, with fewer accidents and errors, production is usually increased, and a plant's labor and community relations are improved. ■ If noise or vibration from the intake or discharge of internal combustion engines, blowers, turbines, compressors, gas or steam vent valves, pressure regulators, and similar equipment is a problem with you, contact Burgess-Manning. Nowhere in the world will you find a company better qualified, with more experience, a better engineering background, and a wider range of products for noise and pulsation attenuation. *Pictured: Burgess-Manning Pulsation Snubbers, Filter-Silencers, and Exhaust Silencers on gas-driven compressors in petroleum pipe line station.*

### SALES ENGINEERING REPRESENTATIVES WORLD-WIDE

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Elizabethton, Tenn. • Chicago • Boston  
Pittsburgh • Buffalo • New York City  
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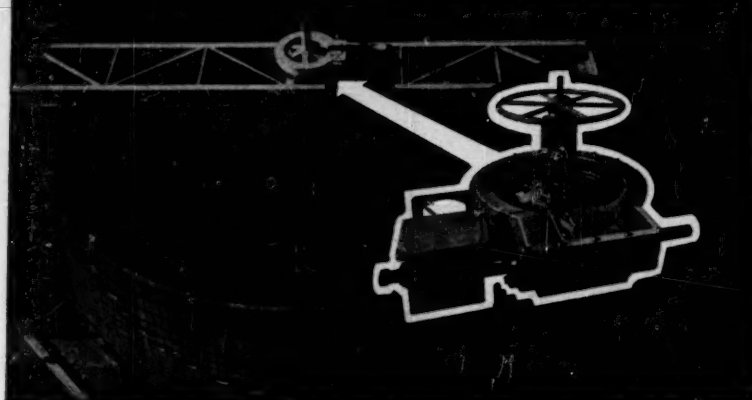
  
The Sound Engineering People

Industrial Silencer Division  
**BURGESS-MANNING COMPANY**

General Offices: 9246 Sovereign Row, Dallas 7, Texas



## DENVER THICKENERS AND CLARIFIERS



**For all water treatment, countercurrent washing, and thickening and clarification operations**

DENVER Thickeners offer simplicity, efficiency and long, trouble-free service in all clarifying and thickening operations.

**FULLY ENCLOSED MECHANISM** with simple, rugged gear and drive mechanism—in sizes through 72" for thickeners to 150' dia.

**SIMPLE, EFFECTIVE OVERLOAD INDICATOR** plus rake lifting device to avoid overloads and lost production.

**LABORATORY TESTING SERVICE** supplies reliable data on Settling Rates, Final Density, Effect of Flocculating Agents, Thickener Unit Area, Overflow Clarity.

## DENVER Adjustable Stroke DIAPHRAGM PUMPS

**...for handling and metering thickened solids**

Stroke adjustable while pump is operating. Low head design...anti-friction bearing construction. Specialty-shaped nylon reinforced rubber diaphragm gives long life. Sizes 1" to 10", simplex and duplex. Capacity to 1000 gpm. Rubber covered or stainless steel construction available. Write for Bulletin No. P8-B12.

Write for Bulletin No. T5-B6.

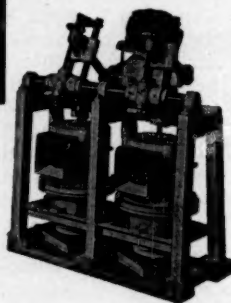


Table at right shows a few of the sizes available:

Pump Size and Type	Cap. Water GPM Min. Stroke	Cap. Water GPM Max. Stroke	Motor HP
2" Simplex	11	25	1/2
4" Simplex	25	70	1
6" Simplex	90	180	3
8" Simplex	165	330	5

# DENVER EQUIPMENT COMPANY

BOX 5268, DENVER 17, COLORADO

Phone  
CHerry 4-4466

See our catalog on  
pages 949-956 in CEC



## LITERATURE . . .

**Recorders.**....Variable-width channel operation provides simultaneous recording of two to six different signal functions on a single chart. A catalog is available.  
170 \*Curtiss-Wright

**Recorders.**....The tremendous power of the 90J (pneumatic) and the 700J (electronic) recorders gives you greater accuracy than ever before. Bulletins 98286 and 98335 offered.  
30 \*Taylor Instrument Companies

**Rotameter.**....The frame of the new Varea-meter is in one rigid piece. Varea-meters come in 1/2" through 3" sizes with 5" and 10" scales. Information is offered.  
161 \*Wallace & Tiernan, Inc.

**Sight-Flow Indicator.**....Bulletin shows 11 styles available, materials of construction, sizes, pressure and temperature ratings, dimensions and maximum and minimum capacities.  
200A OPW-Jordan

**Switches.**....Complete specifications, details, and prices on low pressure and velocity actuated flow switches are described in 30-page catalog.  
200B Henry G. Dietz Co., Inc.

**Thermometers.**....Bi-Metal thermometers make accurate temperature readings sharp and sure at all check points. Further information is found in Catalog 155.  
40 \*Manning, Maxwell & Moore

**Timer.**....Bulletin N-305B describes automatic reset dial timer and includes data on construction, installation, application and basic circuit arrangements.  
200C Automatic Timing & Controls Inc.

## Pipe, Fittings & Valves

**Diaphragm Valve.**....designed with hammer unions, internal components or trim can be changed in less than five minutes. Details in Bulletin HPV-1160.  
BL217 \*Instruments, Inc.

**Fittings.**....Special fittings of any kind can be made. Configurations can be the most simple or the most complex; wall thicknesses can be up to 4" or more.  
39 \*Midwest Piping

**Flexible Connectors.**....A-X flexible metal connectors are designed to handle many types of movement. Complete details are contained in Bulletin A-X97 which is offered.  
141 \*Anaconda Metal Hose

**Glass Pipe.**....Kimax tempered glass pipe never affects your products. Available with complete fittings & accessories for every piping requirement. Catalog.  
33 \*Kimble Glass Co., Sub. of Owens-Ill.

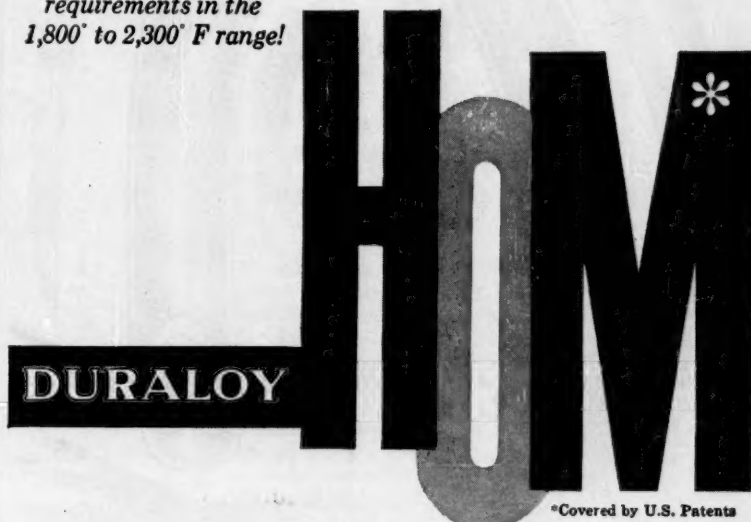
**High-Pressure Valve.**....Redesigned V6 valve is diaphragm-actuated unit designed to handle high-pressure steam, water, gas, oil and air on open and tight shutoff applications.  
200D Republic Flow Meters Co.

**Pipe Fittings.**....Line of stainless steel pipe fittings described in 36-page catalog includes forged cast or machined fittings for service at 150 to 6000 psi.  
200E Cooper Alloy Corp.

\* From advertisement, this issue

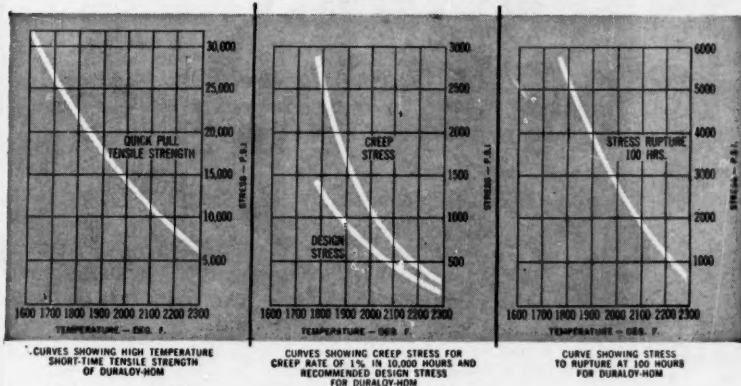
# HOW TO BEAT THE HEAT

for strong high alloy  
requirements in the  
1,800° to 2,300° F range!



## casting alloy

Duraloy "HOM" is a special high nickel alloy developed to produce castings that meet high temperature requirements, especially when castings are subject to oxidizing atmospheres.



Castings of DURALOY "HOM" are now being produced by our three methods: static, centrifugal and shell molded. Write today for additional information on this versatile new alloy.



**DURALOY Company**  
OFFICE AND PLANT: Scottsdale, Pa.

EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.

CHICAGO OFFICE: 332 South Michigan Avenue

DETROIT OFFICE: 23908 Woodward Avenue, Pleasant Ridge, Mich.

**Piping Products.**...Fluoroflex-T piping can handle the most difficult materials up to 500 F. They are resistant to most chemicals. Information. 14-15 \*Resistoflex Corp.

**Tubes.**...Stainless steel pressure tubes to handle super critical steam at 100 m.p.h. They are the answer to many high temperature-pressure problems. 45 \*Timken Roller Bearing Co.

**Valves.**...made from Alloy 20, a stainless alloy of exceptional versatility. Resistant to a broad range of acids as well as alkalis, to help with your corrosion problem. 75 \*Alloy Steel Products Co.

**Valves.**...The right valves for any chemical installation offering a complete line of valve materials, both ferrous and nonferrous. Information. 81 \*The Wm. Powell Company

**Valves.**...Rockwell-Nordstrom valves seal tight. They live longer and save money in valve replacement. Cost no more than ordinary valves. Bulletin V-217 is available. 137 \*Rockwell Mfg. Co.

**Valves.**...Ram type drain valves are designed so that in the closed position the piston or ram extends up into the tank. In open position full flow is assured. Catalog. B178 \*Strahman Valves, Inc.

**Valves.**...These valves are made to specification, machined from solid stock (not cast) using best alloy steels. Plates are machined (not stamped) for close tolerance fit. BR214 \*J. H. H. Voss Co., Inc.

**Valves, Pinch.**...Massco-Grigsby pinch valves have patented "hinge" sleeve and patented Flex Seal ends. No working parts in contact with pulp or fluid. Cat. 609. 162 \*Mine and Smelter Supply Co.

## Process Equipment

**Centrifugal Classifiers.**...offer precise particle control. The Bird Research & Development Center is equipped to furnish prompt and authentic test data. 2 \*Bird Machine Company

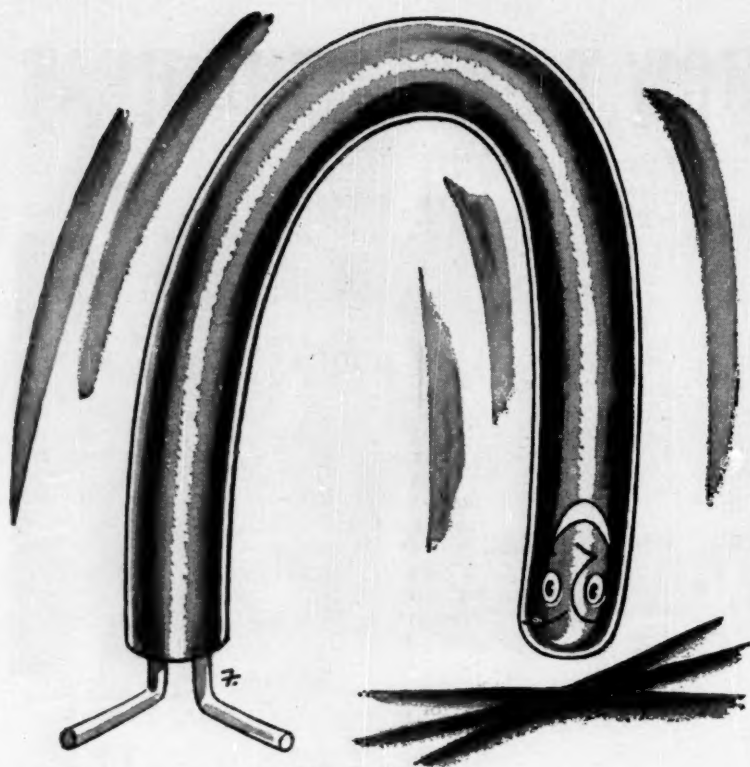
**Centrifugals.**...Batch-Master centrifugals combine rapid bottom unloading with inherent stability of patented Center-Slung suspension. Illustrated bulletin. 189 \*American Machine & Metals, Inc.

**Classifiers.**...can be operated in series to obtain several closely sized fractions in one continuous operation. Further information is available. 171 \*Buell Engineering Co.

**Continuous Dewatering Presses.**...Catalog "A" contains complete information that can help you with your Pressing, Drying and Cooling problems. BR218 \*Davenport Machine & Foundry

**Dissolvers.**...For use with any product requiring mixing, dissolving, dispersing, emulsifying or deagglomerating. Further details are available on request. L214 \*Morehouse-Cowles, Inc.

\* From advertisement, this issue



## **Ceramo<sup>®</sup> Thermocouples** **will bend over backwards** **to fit your job!**

All of us "Ceramo\*-Couples" can bend to almost any configuration, and we don't break our skins, or lose insulation either! When they put us together, they did the job "right."

Over ten years ago, Thermo Electric invented us. Since then, we've multiplied to so many types and sizes that we can do almost any job — and do it better too! We measure temperatures from minus 450°F to 4000°F and higher. Pressures up to 50,000 psi. don't bother us either. We're rugged! We always give you accurate, fast, sensitive and stable temperature readings.

Find out about our whole family —

**WRITE TODAY FOR YOUR THERMOCOUPLE CATALOG TC-4**

More than 48 pages of profitable information on every type of Thermo Electric Thermocouples.



\*Ceramo<sup>®</sup> — Thermo Electric's ceramic insulated, metal sheathed thermocouple wire.

**THERMO ELECTRIC Co., Inc., Saddle Brook, New Jersey**  
In Canada: **THERMO ELECTRIC (Canada) LTD., Brampton, Ont.**

**20 YEARS • Temperature Measuring Systems and Components**

### **LITERATURE . . .**

**Drying Equipment . . .** New catalog No. 201 contains detailed descriptions of the complete line of Drying Equipment. It is available on request.  
R203 \*J. P. Devine Mfg. Co.

**In-Line Blending System . . .** mixes fluids right in a pipeline. Eliminate batch mixing, holding tanks, and give great accuracy. Many types of systems are available.  
133 \*Fischer & Porter Co.

**Ion Exchange . . .** Large-scale capacity is available for custom processing at one of the country's largest ion-exchange facilities. Information is available.  
TR218 \*Michigan Chemical Corp.

**Mill . . .** Pulver-Mill does in one step what used to take two. Designed for fine grinding and precise end product classification. Bulletin 093.  
R184 \*Sturtevant Mill Co.

**Mills . . .** No matter what your grinding problem there is a mill for the job. Line includes Cascade mills, rod mills, disc-roll mills, tube mills and others.  
166 \*Hardinge Co., Inc.

**Prilling Process . . .** Information on this proven prilling process is contained in a new brochure including comprehensive data and flow sheets.  
95 \*The Chemical & Industrial Corp.

**Process Equipment . . .** for any process requirement. A new brochure, "From Arc to Atom" has been prepared giving details and is available on request.  
44 \*A. O. Smith Corp.

**Thickeners & Clarifiers . . .** for all water treatment, countercurrent washing & thickening & clarification operations. Bulletin T5-B6 is available on request.  
200a \*Denver Equipment Co.

**Tornado Mills . . .** A handy chart which shows direct comparison that these mills produce more usable material per hr. than conventional mills is available on request.  
216 \*F. J. Stokes Corp.

### **Pumps, Fans & Compressors**

**Centrifugal Compressors . . .** to meet your specific needs. Four basic casing types can be combined into multiple-unit installations to meet any pressure requirement.  
R164 \*Ingersoll-Rand

**Compressor . . .** Construction features and components of a six-stage, single-casing, water-cooled centrifugal compressor are described in bulletin 16B9987.  
204A Allis-Chalmers Mfg. Co.

**Compressor, Piston . . .** assures absolute contamination-free compression of dry or moist gases. Unique ringless piston & frictionless piston rod. Information available.  
182 \*Sulzer Bros., Inc.

**Compressors . . .** H-line compressors include a wide variety of sizes and capacities, from 300 to 40,000 icfm. Specific information is available on request.  
91-92 \*Elliott Company

\* From advertisement, this issue



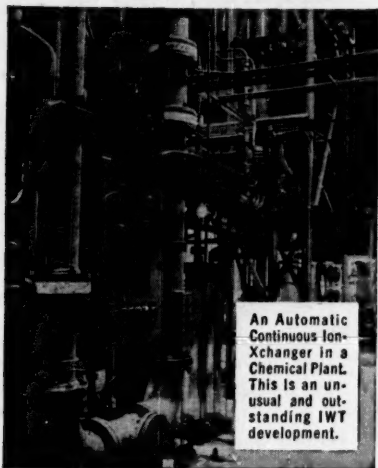
# ILLCO-WAY

DESIGNERS  
AND  
BUILDERS

MODERN  
EQUIPMENT  
FOR

ionXchange

## SPECIAL EQUIPMENT



An Automatic Continuous Ion-Exchanger in a Chemical Plant. This is an unusual and outstanding IWT development.

## DESIGNED FROM EXPERIENCE

Since ion-exchange has become applicable to so many chemical processes, we have become adept at adapting it. For example:

- To a west coast food processor. Automatic ion-exclusion and ion-exchange equipment produces USP grade glycerine from saponification crude, without distillation.
- To several midwest corn syrup producers. Automatic equipment for de-ionization. (Our broad experience dates from 1948.)
- To a uranium processing mill. A continuous IonXchanger produces high-purity uranium tetrafluoride from yellow cake.
- To three chemical plants. Our equipment removes alkali metals and heavy metals from citric acid, and heavy metals from tartaric acid.

## RESEARCH AVAILABLE

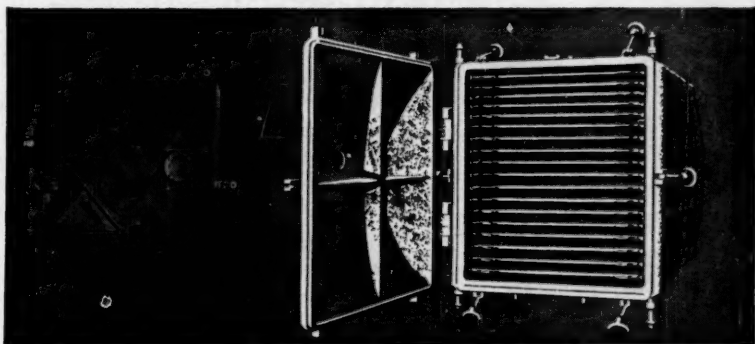
Our Research Department, with wide experience and good equipment, has developed many new applications for ion-exchange, and will cooperate on a confidential basis in research and pilot plant work. Contact us direct, or through our representatives . . .

ILLINOIS WATER TREATMENT CO.  
840 CEDAR ST. ROCKFORD, ILLINOIS  
NEW YORK OFFICE: 131 E. 31st St., New York 17, N.Y.  
CANADIAN DIST.: Plumb & Sullivan, Ltd., London, Ont.

# DEVINE VACUUM CHAMBER DRYERS

More and more manufacturers are getting to know about vacuum processing, know that it offers special benefits to them. Not as many, however, know that Devine Manufacturing Company was the first to introduce vacuum processing in this country over half a century ago. Ever since, Devine has been solving problems for a constantly growing list of firms and industries with this simple yet most versatile processing tool.

Even special problems do not necessarily involve elaborately special equipment. The dryer pictured below, for instance, is a Devine Standard Vacuum Chamber Dryer that has been only slightly modified. Yet it proved the answer for a leading chemical manufacturer who needed a safe, low temperature quick-drying system that would not damage his heat-sensitive product, would not cross-contaminate the load. Let us help solve your vacuum drying problems, too.



Phenolic resin-lined double door chamber dryer designed to process heat-sensitive chemicals..

Other Devine products for the Chemical Processing Industry:

Vacuum Dryers, Blenders and Mixers, Ball Mills, Autoclaves, Paint and Paste Mixers, Agitators, Impregnators, Kettles, Vacuum Pumps, Jacketed Valves, Pipes and Fittings, Code Design and Fabrication.

Write for our new catalog No. 201, with detailed descriptions of our complete line of Drying Equipment.

A UNIT OF  
**COX**  
INDUSTRIES

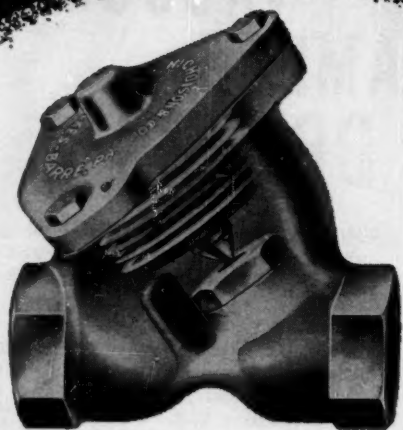
J. P. DEVINE MFG. CO.  
49th St. & Ave. H  
PITTSBURGH, PA.

New York Office: 500 Fifth Avenue, New York 36, N.Y. Phone: Wisconsin 7-7769  
Export Office: 50 Church St., New York 7, N.Y. Cable Address: "Brosites"



## A NEW DEVELOPMENT

FOR STEAM-SAVING EFFICIENCY



Nicholson Thermostatic Steam Trap Model N-150



- ALL STEEL CONSTRUCTION
- JUST ONE WORKING PART

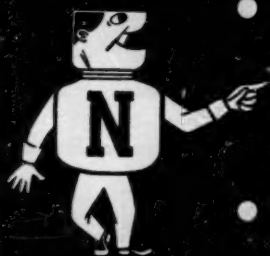
RUGGED MONEL BELLOWS

- NEW BAFFLE\* . . . deflects steam upward and away from the orifice to surround the bellows



- FREEZE PROOF WHEN INSTALLED VERTICALLY

CAN BE TESTED AND INSPECTED WITHOUT BREAKING PIPE CONNECTIONS



- COMPACT, LIGHTWEIGHT, EASY TO INSTALL

- FOR TRACER LINES also Plating Tanks Platen Presses • Unit Heaters • Sterilizers and various types of Cooking and Laundry Equipment. N-150 Traps can also be used as air vents for Receivers, Water Heaters, Mechanical Traps, etc.



W. H. NICHOLSON AND CO.  
12 Oregon St., Wilkes-Barre, Pa.

\* Patent applied for

## LITERATURE . . .

**Compressors, Centrifugal.** . . . Model G compressors are available in 6 models with capacities from 500 to 15,000 cfm at 3 to 20 psig. on air service. Bulletin 2468-11.  
159 \*Joy Manufacturing Co.

**Compressors, Rotary.** . . . have no reciprocating parts, no valves, no metal-to-metal contact in the compression chamber resulting in minimum downtime expense.  
8-9 \*Fairbanks, Morse & Co.

**Diaphragm Pumps.** . . . Adjustable stroke diaphragm pumps for handling and metering thickened solids. Bulletin P8-B12 is available for complete information on these pumps.  
200b \*Denver Equipment Co.

**Dust Collectors.** . . . Cyclo-trell units are available in a wide range of sizes and types including C10, C24, 1C and ICL. Further information in Bulletin 300.  
32 \*Research-Cottrell, Inc.

**Evaporators.** . . . An eight page treatise, Forced Circulation Evaporators, on salting and non-salting types, single & multiple effects is offered. Bul. SW205.  
180 \*Swenson Evaporator Co.

**Feeder.** . . . Merchen feeder gives you greater feeding accuracy because of its sensitivity. It is compact & gives you hour-to-hour accuracy for feeding & blending. Inform.  
160 \*Wallace & Tiernan, Inc.

**Feeding Systems.** . . . Continuous feeding/blending saves material, reduces costs, controls quality & results in bigger processing profits. Facts booklet offered.  
R174 \*B-I-F Industries

**Filter.** . . . EimcoBelt continuous belt filters successfully handle slurries that have always been considered impossible for vacuum filtration. Bulletin FE-2053 is offered.  
Cover \*Eimco Corp.

**Filter, Pressure Leaf.** . . . with the new low cost oscillating jet sluice. Available in vertical or horizontal tank filters. Further information is available on request.  
143 \*The Duriron Co., Enzinger Div.

**Filters.** . . . are available in completely automated models for production-line filtration. Complete data on Niagara filters and their advantages is available.  
188 \*American Machine & Metals, Inc.

**Filter Press.** . . . can be used for a multitude of applications—go from one chamber to full capacity. The Sperry Catalog is available for information.  
151 \*D. R. Sperry & Co.

**Flash Drying Systems.** . . . offer flexibility in application. This is a versatile system that can be readily adapted to your particular problem. Catalog #82E.  
104a \*Combustion Engrg., Inc.

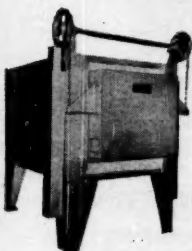
**Fluid Bed Systems.** . . . A supplementary form of Raymond drying systems for special applications. Information is contained in Bulletin 88E which is available.  
104b \*Combustion Engrg., Raymond Div.

**Generator.** . . . Nitro-Gen generator can produce gases of oxidizing & reducing characteristics by varying gas/air ratio. Further details are available in Bul. 5901-N1.  
R205 \*C. I. Hayes, Inc.

\* From advertisement, this issue

## SOLVE HEATING PROBLEMS FOR CHEMICAL PROCESSING • DRYING • ACTIVATING

ONLY TRENT BOX TYPE FURNACES  
offer these performance advantages:



- Clean, Uniform Heat to 1260°C.
- Operate from Standard Voltages
- Standard Switches and Controls
- Require No Transformers
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**Generators, Inert Gas . . . . .** offer precise fuel control & automatic safety. If you need inert gases for blanketing, purging & protective uses, see Bulletin L-10.  
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L164 \*Aerovent Fan Co., Inc.

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94 \*Chempump Div., Fostoria Corp.

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205A National Foam System, Inc.

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190 \*Manzel

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205C Bellofram Corp.

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18-19 \*Blaw-Knox

\* From advertisement, this issue



Carl G. Paulson,

Director of Hayes Research and Development Group, Reports . . .

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Assume you face the need for high purity nitrogen at a low per-unit cost figure. You want to use it as a heat treating atmosphere . . . or as a "blanket" for hydrocarbons or food products . . . or for any one of a number of industrial applications. How can you bring this safe, inert gas out of the lab and into general use without inflating your costs?

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**KETTLES:** (4) 300 Gal. S/S; Groen 80 gal. S/S on pedestal base, Model GPT; Groen 60 Gal. Mod. AH S/S gas fired, hermetically sealed.  
**MILLS:** (2) Morehouse HI R Mills; Fitzpatrick Model D-6.  
**MIXERS:** Baker Perkins 300 Gal. Size 18 NIM; Gredge & Gray 4,000#.  
**PRESSES:** Stokes Mod. DDS 2 Rotary; Kux Model 25; Colton Mod. 3 RP and 4½ T.  
**SIFTERS:** Tyler Hummer w/hopper & 2 vibrators; J. H. Day & Selectro 4 x 8 single deck; Jigger 2 deck; Rotex Mod. 842.  
**MISC.:** 3 x 10 Stokes S/S Cooker; NRM Cub Plastic Extruder Style 5008; many glass lined tanks; Stokes & Smith Model HG-84 filler; Triangle Models U-2 and Electri Pak Fillers.



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# LIQUIDATIONS

## OHIO

- 2—Kilby NICKEL Dbl. Effect Evaporators, 2000 sq. ft. ea. effect.
- 1—Kilby NICKEL Single Effect Force Feed Evaporator, 1200 sq. ft. Above with condensers, piping and pumps.
- 2—12,000 gal. NICKEL Clad Tanks, 12'x14'.
- 5—8,500 gal. NICKEL Clad Tanks, some agitated.
- 1—1,000 gal. NICKEL Clad Tank, 5'x8'.
- 2—Oliver 5'3"x4' NICKEL Clad Rotary Vacuum Salt Type Filters.
- 2—Pfaudler 300 and 200 gal. Glass Lined Jacketed Agitated Reactors.
- 1—Sperry 30" C.I. Filter Press, 27 chambers.
- 1—Bufflovak 32"x90" Double Drum Dryer.
- 4—Feinc 8'x12' Rotary Vacuum Steel Filters, string discharge.
- 1—Peabody Gas Scrubber stainless steel 11,000 CFM at 145°F with fans and XP motor.
- 1—Peabody Gas Scrubber stainless steel 6,000 CFM at 125°F with fan and XP motor.
- 2—6'6" dia. x 60' Rotary Dryers.
- 1—5½'x4½'x50' Rotary Dryer.
- 1—5½'x4½'x60' Rotary Dryer.
- 3—Dorr 80' dia. Thickeners with agitator and drive.
- 4—Dorr 40' dia. Thickeners with agitator and drive.
- 3—Vogt 387 sq. ft. Rotary Pressure Filters.
- 2—Chicago Pneumatic 26" x 14" Vacuum Pumps with 150 HP motors.
- 3—Fuller Kinyon Pumps H5 and H6.
- 1—Link-Belt 24" x 90' Troughing Belt Conveyor.
- 5—NICKEL Centrifugal Pumps, 2", 3".

- 1—Raymond #73612 Super High Side 6-Roll Mill, with whizzer, cyclone, piping and motors.
- 1—Raymond #6669 Super High Side 6-Roll Mill, with whizzer, cyclone, piping and motors.
- 1—Raymond 12' dia. Double Whizzer Air Separator.
- 2—Sturtevant 14' dia. Air Separators.

# BRILL FOR VALUES

## CENTRIFUGES

- 2—Sharples C-20 and C-27 Super-D-Hydrator, 316 S.S.
- 1—Bird 18" x 28", Solid Bowl, Continuous, 304 S.S.
- 2—Bird 24" x 38" Solid Bowl Continuous 304 S.S.
- 1—Bird 40" x 60" Solid Bowl Continuous, 316 S.S., unused.
- 3—Sharples PY14, PN14 Super-D-Centers 316 S.S.
- 2—Sharples #16, 304 S.S., 3 HP motor.

## REACTORS—EVAPS—COND—TANKS

- 1—Pfaudler 125 gal. 304 S.S. Jacketed Agitated Reactor, 150# int., 125# jacket.
- 3—Pfaudler 200 gal. glass lined jacketed Kettles.
- 2—Pfaudler 850 and 650 gal. Steel Jacketed, Agitated Reactors.
- 1—650 gal. 304 S.S. Reactor with 100 sq. ft. Bayonet Heater.
- 1—O. G. Kelly 3000 sq. ft. 309 S.S. force speed Evaporator UNUSED.
- 1—550 sq. ft. Bufflovak monel single effect Evaporator.
- 10—400 to 1200 gal. vertical 304 S.S. Tanks, open end closed.
- 6—7500, 6000 and 2000 gal. Rubber Lined Tanks.
- 1—1500 gal. Stainless Pressure Tank, 5' x 10', 90#.
- 1—2000 gal. horiz. 304 S.S. Tank, 5' x 12'.
- 1—2500 gal. vertical 304 S.S. Tank, 8' x 7'.
- 1—10,000 gal. rubber lined Tank 10' x 17'6".
- 5—2700, 2200 gal. 304 S.S. Vertical Agitated Tank with Coils.
- 1—4200 gal. 316 S.S. Vertical Tank, 8' x 12'.
- 1—5500 gal. 316 S.S. Clad Pressure Tank, 250 psi.
- 1—12,000 gal. horiz. steel Pressure Tank, 7'6" x 36", 200 psi.
- 4—Stainless Heat Exchangers; 536, 370, 315, 250 sq. ft.
- 1—24" dia. x 35', 304 S.S. Bubble Cap Col.

## FILTERS

- 1—#5 Sweetland Filter 304 S.S. 120 sq. ft.
- 1—Oliver 6' dia. Horizontal Filter, 316 S.S.
- 1—Oliver 4' dia. Monel Horizontal Filter.
- 1—Oliver 5' x 6' Steel Rotary Vacuum Precat Filter.
- 1—U.S. 200 sq. ft. 304 S.S. Auto-Jet Filter.
- 1—Hercules 400 sq. ft. 304 S.S. Pressure Filter.
- 1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaporette housing.
- 1—Feinc 3' x 1' 316 S.S. Rotary Vacuum Filter.
- 2—#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft.

## DRYERS

- 1—Bufflovak Vacuum Shelf Dryer with 17—60" x 80" shelves.
- 2—Bufflovak 42" x 120", atmospheric double drum Dryers, complete.
- 1—Bufflovak 32" x 90" Atmos. Twin Drum.
- 2—Davine 4' x 9' single drum, atmospheric Dryers.
- 2—Davine 4' x 9' single drum, atmospheric.
- 1—Bufflovak 3' x 10' Rotary Vacuum Dryer.
- 1—Stokes 4' x 20', 304 S.S. Rotary Vacuum.
- 6—Louisville Rotary Steam Tube 5' x 25', 6' x 30', 6' x 50' Dryers.
- 2—Louisville 8' x 50' Stainless Steel lined Rotary Dryers.
- 9—Rotary Dryers 3' x 36', 4' x 40', 6' x 50', 6' x 60', 7' x 80', 8' x 87'.
- 1—Louisville 4½' x 25' Inconel Rotary Dryers.
- 2—Link Belt, 7'3" x 25½' 6'4" x 24", S.S. Louvre Dryers.
- 1—Stokes model 38-A Tray Dryer with 16—36" x 36" S.S. Shelves.
- 2—Atmos. Tray Dryers, 16 shelves, 40" x 24".
- 2—10' and 4' dia. 304 S.S. Spray Dryers.
- 2—Wyssmont Dryers, 304 S.S. 6'2" and 9'6" dia.

## MIXERS

- 1—Abbe 110 gal. 304 S.S. Jacketed Agitated Vacuum Dispersall Mixer.
- 2—Day Imperial 150 gal. jkted. double arm.
- 2—Baker Perkins 150 and 100 gal. jacketed double arm Sigma blades.
- 1—Baker Perkins 50 gal. jacketed, double-arm.
- 5—Day "Cincinnati" double arm, 250 and 100 gal.
- 2—Steel jacketed Powder Mixers, 225 and 350 cu. ft.
- 1—Day 1500# Powder Mixer 304 S.S.
- 1—Patterson 6' dia. Conical Blender 15 HP.
- 1—3' dia. Simpson Intensive Mixer.
- 1—2' dia. Simpson Intensive Mixer 304 S.S.
- 1—45" dia. Lancaster Mixer 7½ Hp motor.
- 1—Patterson Kelley 150 cu. ft. Twin Shell Blender.
- 1—Patterson 80 cu. ft. Conical Blender, 304 S.S.

## MISCELLANEOUS

- 3—Kinney Vacuum Pumps, 1000 cfm, 10 microns, 15 HP.
- 2—Hardinge 5' x 22" steel lined conical Ball Mills.
- 3—Mikro Pulverizers, 15H, 15I and Bantam.
- 3—Abbe 2½" x 3' porcelain lined Pebble Mill XP motor.
- 1—Raymond 10" vert. Mill, 10 HP.
- 1—#18 Cumberland Rotary Cutter.
- 3—Swenson Walker Continuous Crystal-lizers, 24" x 30' sections.
- 1—#24 Rotex Sifter, 20" x 64", Quadruple deck.
- 4—Stokes Rotary Tablet Machines DD2, DDS2, RD4 and RB2.
- 5—Day Roball Sifters, 40" x 120", 40" x 84", Double Deck.
- 3—Nash H6 Vacuum Pumps.
- 4—Stokes Rotary Tablet Machines DD2-DDS2-DD3-RB2.

Partial List of Values—Send for Complete Details

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Hartig electrically Heated Extruders,  
4½" and 6" with Controls.

Link-Belt Roto Louvre Dryer, 502-20.

F-B Unused 2 Roll Mills, 14" x 30".

Bufflovak Vac. Double Drum Dryer  
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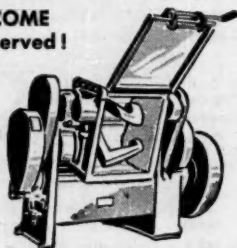
Stokes Vacuum impregnating  
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3000 Gal. Nickel Clad Reactor, 7"x11",  
Jacketed and Agitated.

Cornell Stainless Model C-D26 Versa-  
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SAVE \$2250.. on  
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Baker Perkins  
Size 14-50 Gal.  
Jacketed Dbl. Arm  
Sigma MIXER . . .

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Stainless Centrifugals from 30" to 60";  
A.T.&M. Tolhurst, Fletcher, etc.

2 Sharples Stainless Steel Model PN14  
Super-D-Canters.

4311 S 1 Sharples C 27 Super-D-Hydra-  
tor in Type 316 Stainless with 40 HP  
motor.

5147 S 13-14 Two Bird Continuous  
Screen Type Horizontal Centrifuges;  
Monel & S.S.; 24" x 24".

2 Bird Rubber Covered, 48" with Plows;  
Fume Tight; 40 HP.

**REACTORS—PRESSURE VESSELS**

2 Stainless 400 gal. Reactors Jktd. Agtd.  
by Patterson and Struthers Wells.

6 Dorr-Oliver Stainless Steel Thickeners  
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Stainless Reactor, 2000 gal. Fully Jktd.  
Agitated.

Lancaster Stainless Lined Rotary Reactor  
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Pfaudler Gl. Lined Reactors; all sizes  
from 50 to 1000 gal.

Mojonnier Stainless Vac. Pans; 3' x 10'  
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**ROTARY VACUUM FILTERS**

3" x 2" Monel. 5'3" x 8' Stainless.

(2) 5'3" x 3" Steel or Rubber.

Feine S/S Rot. Vac. Filter 3' x 1'.

Oliver Cont. Rot. Vacuum Filters.

Panel Type; 8' x 8' and 8' x 10'.

**MIXERS ALL TYPES**

Baker Perkins Jktd. 5 gal. UNE-7, Dbl.  
Arm Mixer with pressure cover; 30  
HP

Readco Jktd. 15 gal. Dbl. Arm Sigma  
Blade Mixer.

Baker Perkins Stainless Steel Lab Mixer;  
Sigma Arms; 6½" x 9½" x 11½".

Baker Perkins Jktd. Mixers, 50 gal., 150  
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hanite Liner magnetic-coupled to 400  
HP Motor

3 Allis Chalmers 7' x 22' Continuous  
Ball Tube Mills, Meehanite Liners,  
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400 H.P. Motor now operating in  
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OMAHA, NEBRASKA**

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still columns, 44' high.
- 5—Bufflovak 42" x 120" dbl. drum  
dryers, ASME 160#
- 2—Amer. 36" x 84" dbl. drum dryers
- 9—Davenport #1A #2A dewater-  
ing presses, vari-drives
- 2—French Oil type 2-S screw-type  
extraction presses 300 PSI, 60 HP.
- 5—Shriver 48" Cast Iron P. & F.  
filter presses, (50) chambers
- 2—19,900 sq. ft. quadruple effect  
calandria type evaporators
- 6—691 sq. ft. dbl. pipe coolers
- 3—American 654 sq. ft. spiral steel  
heat exchangers
- 18—Tubular heat exchangers, cop-  
per tubes: 1500, 1350, 1130, 637,  
380, 290, 184, 176, 156 sq. ft.
- 2—9500 gal. horiz. cookers, 9' dia.  
x 20' long, ½" shell & heads.
- 2—Warren 12" x 12" cent. pumps
- 250—Steel centrifugal pumps, 1" to  
12", 1 HP to 150 HP
- 2—Aldrich triplex pumps, 175# WP.
- 3—1000 KVA trans., 13800—460 v.

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**COMPRESSORS**

No better values at any price

- 72 CFM 1500 PSI 6½-3½-13x7 CP
- 138 CFM 100 PSI 7x7, Ing. ES, CP & Joy
- 254 CFM 500 PSI 9½x4½x11 Ing. ES2 (NPW)
- 288 CFM 100 PSI 9x9 Ing. Worth, CP
- 311 CFM 1500 PSI 10½x7½-3½-13 IR-ES3
- 420 CFM 40 PSI 12x9 Gardner (Ethylene)
- 465 CFM 100 PSI 12x11-IR-ES C.P.T. Worth HB
- 502 CFM 125 PSI 12x13 Worth HB
- 676 CFM 110 PSI 15-9½x12 Ing. XRE
- 686 CFM 100 PSI 14x13 Ing. ES
- 805 CFM 125 CFM 17-10x12 CP oes
- 1030 CFM 60 PSI 13-13x12 IR-XRE
- 1852 CFM 110 PSI 23-14x14 Ing. XRE
- 300 HP GE Syn 3-60-440 (2) 1952
- 2200 CFM 100 PSI 26-15x18 Ch. Pa. oes 350-HP
- 2610 CFM 45 PSI 20-20x14 Ing. XRE 250 HP Syn.

**AMERICAN AIR COMPRESSOR CORP.**  
Chem. Road, North Bergen, N.J. UNION 5-1397

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hydraulic closing. Motor driven sluicing  
devices and special deep bottoms. Very  
excellent condition.

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**S.S. VACUUM DRYER**

Stokes 3 ft. x 15 ft. stain. stl. Rotary Vacuum  
Dryer. ASME jacketed for 50 P.S.I. and S.S.  
steam shaft. With condenser, dust collector  
and drive. Excellent.

**BEST EQUIPMENT COMPANY**

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46"x41"x5/16" Vulcan 316SS Bubblecap, 40 trays 70 caps/tray 100 PSI.  
36"x21"x1/4" 316 ELC SS Packed, 15 PSI.  
36"x20"x3/16" Vulcan 316SS Packed 100 PSI.  
30"x23"x1/4" 316 SS Packed 75 PSI.  
14"x17"x1/4" 316 SS Packed  
12"x18"x3/16" 34755 Packed 100 PSI.  
18"x66"-7' cone bottom, 1/4" 316SS Packed Absorber Column Stainless Packing

## • COLUMNS •

72"x16"x3/4" Copper 8 Bubblecap trays  
48"x25"x1/4" Copper 35 Bubblecap trays  
42"x28"x3/4" Copper 40 Bubblecap trays  
36"x11"x1/4" Copper 15 Bubblecap trays  
20"x27" GLASS LINED 50 PSI full vacuum  
16"x21" GLASS LINED 25 PSI full vacuum  
16"x10" GLASS LINED 25 PSI full vacuum  
84"x25"x3/4" Steel 8 Bubblecap trays  
60"x68"x5/16" Steel 35 Bubblecap trays  
36"x38"x5/16" Steel 35 trays with Reboilers  
30"x61"x3/4" Steel 24 trays

## • CENTRIFUGES—FILTERS •

Sharples C-27 Super-D-Hydrator Stainless  
Sharples C-20 Super-D-Hydrator Stainless  
40" Fletcher Susp Centrifuge Perl. 15/7 1/2 HP  
30" Susp Centrifuge—Imperforate Stainless  
Sharples #6 Super Centrifuge Stainless Bowl  
5'3"x3" Oliver Precoat Rot Vac Filter SS  
4'x1' Bird Young Rot. Vac Filter Stainless  
36"x24" Gossin Rot. Vac Filter Stainless  
48"x36" Stainless Nutsche Filter  
#11 Sweetland 840 Sq. ft. 48 Stainless leaves  
18"x28" Bird Continuous Stainless

## • DRYERS—KILNS •

8'x8"x70" Ruggles Cole Dryer  
8'x60"x3/4" Al. Chalmers Welded Kiln  
7'x120"x8/16" Bethlehem Fdy. Kiln  
7'x45"x1/4" Link Belt Welded Kiln  
604-24 Roto-Louvre Dryer Stainless Steel  
6'x124"x3/4" Vulcan Kiln  
502-16 Roto-Louvre Dryer  
4'x40"x3/4" Welded Dryer NEW Shell  
3'x16" Stainless Rotary Dryer

## • REACTORS •

Pfaudler 500 gal ELL Gl. Lined Jkt. Agit.  
Dopp 1700 gal Ni-Resist Jkt. Agit.  
Dopp 1000 gal Ni-Resist Jkt. Agit.  
Vulcan 1000 gal Everdur Coiled, Agit.  
Patterson 1000 gal Steel Jacketed  
Bullovak 900 gal Stainless Agit. Elec. Heat  
Patterson 500 gal Steel Jkt. Agit. 2HP XP  
Alloy Tank 750 gal Stainless Pressure Still  
Alloy Tank 300 gal Stainless Pressure Still

## • COMPRESSORS—VACUUM PUMPS •

Clark 9820 CFM 149PSIA Suct 239PSIA Dis  
Al. Ch. Centrifugal 7500CFM @ 42.5PSI, 1250HP  
Nash #9 Compressors 2150 CFM @ 16PSI  
Worthington YO 1360 CFM @ 35 PSI, 150 HP  
Worthington 1015 CFM @ 35 PSI Steam Driven  
Norwalk Hydrogen Compressor 5 CFM 15000PSI  
Nash #4 Vacuum Pump 650 CFM @ 15"

## • STAINLESS STEEL TANKS •

11000 gal 12"x15"x3/16" Agitated  
11000 gal 8"x29"x3/16" dished 25 PSI  
4500 gal 6"x25"x1/4" dish/cone 25 PSI Coiled  
4000 gal 8"x12"x3/16" dished Coiled  
3500 gal 8"x9"x5/16" dished heads  
1500 gal 6"x9"x1/4" dished heads  
1200 gal 5"x8"x1/4" Agitated  
750 gal 4'x6"x5/16" dished 42 PSI  
500 gal 4'x5"x5/16" dished heads  
500 gal 4'x5'6"x1/4" flat Agitated  
(20) Tanks 50 to 400 gal cone agitated

## • TANKS •

12000 gal Aluminum 10"x23'3" dished heads  
13000 gal Aluminum 9'x23'3" dished heads  
7000 gal Aluminum 10'x14' dished heads  
3500 gal Cooper 8'x9'x1/2" dished Coiled  
2000 gal Copper 7'x7'x1/4" dish Agit Coll  
500 gal Copper 4'x5'x5/16" dished Coiled  
20000 gal Steel 12'x24'4"x7/8" dished 100 PSI  
10000 gal Steel 8'x30' dished Coiled  
10000 gal Steel 8'x30'x3/4" dished 60 PSI  
6500 gal Steel 7'6"x20'x1/4" dished  
2500 gal 5'x15'6" Herasite lined 68 PSI  
2250 gal Steel 6'x19'x5/16" dished 114 PSI  
1250 gal Steel 5'x8' dished Agit. Coll

## • HAMMERMILLS—CRUSHERS •

Penna SX13 150TPH, 400HP Synchronous Drive  
Dixie Mogul #5060 Manganese Lined  
Raymond #50 Imp Mill Model C2-855  
Bacon Hevi-Duty Style B 20"x8" Jaw Crushers  
Universal 5"x8" Jaw Crusher Manganese Jaws  
Starvant 8"x5" Double Roll Crusher

## • SPECIAL ITEMS •

TRIPLEX PUMP—2 1/4"x4" Stainless 2000PSI  
BLOWER 2500 CFM 10 PSI Read Standardair  
GAS PUMP 20"x20" Roots Connorsville "RS"  
GAS METER 8"x24" Roots 60000CFH  
CRYSTALLIZER Squire 40"x30" Agit. Jkt.  
CRYSTALLIZER Bullovak 6' Vacuum Jkt. Agit  
CRYSTALLIZER Swenson 24"x20" Jkt. SS304  
AIR DEHYDRATOR-Anders SFA Automatic  
ABSORPTIVE DRYER-Kemp FE02-S Dual Tower  
WHIZZER Raymond 30" Double  
SIFTER 30"x96" Roball STAINLESS Screen  
SIFTER 40"x84" Roball Single Deck  
SIFTER 60"x84" Rotex STAINLESS 1 Deck  
SIFTER 48" Sweco-Triple Deck Model A9062  
CONVERTER—St. Wells 10'x23' 10000 sq. ft.  
FURNACE—St. Wells 1MM/WTU Oil fired  
HEATER 150KW Hot Oil Hynes Elec. Co.  
BRIQUETTE PRESS Komarek Greaves 27"x24"  
MIXER 300 gal. B.P. STAINLESS Sigma 18DIM  
BLENDER Conical 6' Paterson 69CF 10 HP  
BLENDER Conical 12' Paterson 500CF SS clad  
EVAPORATOR—435 Sq. ft. Single Effect  
TUBE MILL AL.Ch. 7'x24" Mang. Lined 500 HP  
BALL MILL Traylor 8'x11' Steel Lined 300 HP  
CENTRIFUGAL PUMPS—STAINLESS—1" to 3"  
10 to 750GPM 35 to 100' Head

## • CONDENSERS—HEAT EXCHANGERS •

983 Sq.ft. All Copper 3/4"x16ga.x8' Tubes  
760 Sq.ft. All Copper 3/4"x14ga.x14' Tubes  
246 Sq.ft. All Copper 3/4"x16ga.x12' Tubes  
6931 Sq.ft. Steel 2"x11ga.x12' Tubes  
1058 Sq.ft. Steel 3/4"x16ga.x10' Tubes  
141 Sq.ft. Steel 3/4"x14ga.x8' Tubes

## • STAINLESS HEAT EXCHANGERS •

2320 Sq.ft. 33"x21"—1"x16ga.x16' Tubes  
1000 Sq.ft. 27"x168"—3/4"x16ga.x14' Tubes  
890 Sq.ft. 22"x20'8"—5/8"x16ga.x14' Tubes  
800 Sq.ft. 23"x17'10"—3/4"x16ga.x16' Tubes  
615 Sq.ft. 22"x15'9"—3/4"x16ga.x10' Tubes  
420 Sq.ft. 18"x9'6"—3/4"x18ga.x8' Tubes  
300 Sq.ft. 14"x19'6"—3/4"x18ga.x12' Tubes  
235 Sq.ft. 16"x8'3"—5/8"x16ga.x7' Tubes  
188 Sq.ft. 11"x16'8"—5/8"x14ga.x12' Tubes  
146 Sq.ft. 11"x13'10"—5/8"x16ga.x9'6" Tubes  
68 Sq.ft. 8"x17'3"—3/4"x16ga.x16' Tubes

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# MULTI-MILLION DOLLAR LIQUIDATION

NORTH LITTLE ROCK, ARK.

**STAINLESS STEEL TANKS**

- 6—13,300 gal., 12' x 15'9", cone top.
- 3—11,500 gal., 11'6" x 15'6", cone top.
- 18—3650 gal., 10' x 7', open top.
- 3—3000 gal., 5' x 19', T347SS, ASME 60 psi, dished heads.
- 60—1350 gal., 4' x 14', T347SS, ASME 60 psi, dished heads, int. coils.
- 9—1300 gal., 7' x 4'6", T321SS, closed
- 3—1100 gal., 4' x 11', T347SS, ASME 60 psi, 3/16" shell, 1/4" heads.
- 27—476 gal., 4'6"x4", open top.
- 54—475 gal., 5'6"x2'6", open top.
- 27—445 gal., 6'x2", open top.
- 3—300 gal., 4'x3', T347SS, ASME 60 psi, dished heads.
- 9—285 gal., 41"x49", open top.
- 9—260 gal., 40"x48", closed top.

**GLASS-LINED TANKS**

- 18—Pfaudler 11,500 gal. horiz. blue glass-lined tanks, 8' x 30', 1/2" shell, 7/16" dished heads, 20 psi. With 75 sq. ft. nickel coil, Aurora St. St. sump pump.

**STEEL PRESSURE TANKS**

- 9—28,000 gal. 11' x 38', dished, ASME 75 psi.
- 11—28,000 gal. 11' x 38', lead-lined.
- 2—14,000 gal., 8' x 36', dished.
- 2—11,000 gal., 8' x 27', dished, ASME 300 psi.
- 5—9000 gal., 8' x 23', dished.
- 54—5200 gal., 6' x 24', dished, 60 psi.
- 3—3300 gal., 6' x 15-6", dished, ASME 125 psi.

**ACID EQUIPMENT**

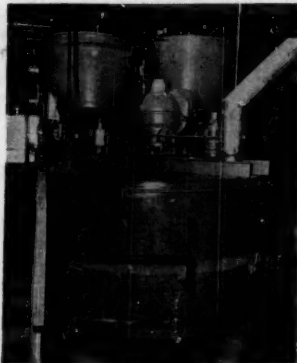
- 4—Cottrell carbon-tube electric-mist precipitators, (88)-tubes, lead-lined shell.
- 8—Graver concentrating drums, 10' dia. x 23' long, lead-lined, with furnaces.
- 8—5500 gal. gas-cooling tanks, lead-lined.
- 25—Acid-cooling tanks, lead-lined.
- 16—Duriron denitrating concentrators, 24" dia. x 15' high, packed w/Amorphous Quartz.
- 4—Duriron 24" dia. x 4' high vac. denitrators.

**FILTER-TANKS**

- 54—24 sq. ft. Pfaudler 475 gal. St. St. filter tanks, 66" x 30", filter plate.
- 27—28 sq. ft. Pfaudler St. St. filter tanks.

**KETTLES—REACTORS**

- 72—1400 gal. Pfaudler blue glass-lined jacketed kettles, 84" dia. x 54" high, open top, Stainless Steel cover, 3 HP Agit., Adj. baffle.
- 18—1250 gal. Pfaudler blue glass-lined jkt. reactors (Sulphonators), 72" dia. x 72" high, closed, 3 HP Agit.
- 54—600 gal. Pfaudler Stainless Steel ammoniating & crystallizing jkt. kettles, 60" dia. x 46" high, open top, Fume hood.
- 72—250 gal. Pfaudler blue glass-lined jacketed kettles, 42" dia. x 36" high, open top, Stainless Steel cover.



Pfaudler 1400 gal. Kettles

**COLUMNS—HEAT EXCHANGERS**

- 16—24" dia. x 15' high Duriron packed columns.
- 1—24" dia. x 33' high Duriron & St. St. packed column.
- 4—24" dia. x 4' high Duriron vacuum denitrating columns.
- 6—1450 sq. ft. T347SS gas condensers, 3-pass Vert. units, inner & outer tubes.
- 3—1000 sq. ft. Duriron cascade-type pipe coolers.
- 3—564 sq. ft. Stainless Steel burner-Preheaters, gas condensers, 3-pass.
- 2—435 sq. ft. Amer. spiral steel exchangers.
- 9—400 sq. ft. Stainless Steel open-pipe coolers, 2 3/4" OD pipe.
- 12—Amer. spiral heat exchangers T316L S/S: 162, 72 sq. ft.
- 48—Duriron pipe coolers, 159, 130, 125, 99, 54, 44, 42, 10 sq. ft.
- 3—18 sq. ft. Ammonia evaporators.

**COMPRESSORS—BLOWERS**

- 3—Worthington 3500 CFM air comp., 24 x 15, type LTC-4, 500 HP gas driven.
- 1—Chicago-Pneu. 3026 CFM air comp., size #19-32-30-18 x 24, horiz. steam driven.
- 8—Elliott turbo-blowers, 11,620 CFM, type O, 15.9 psi discharge, 125 HP.
- 18—Ing.-Rand 6 x 6 x 5 air comp., V-type, 2 cyl., #67D9, type 30, 10 HP.
- 3—Frick 4 x 4 Ammonia comp., type HB.
- 2—Worthington 5 1/2 x 3 1/2 x 3 1/2 air comp., V-type, 7 1/2 HP.

**CENTRIFUGAL PUMPS**

- 20—Worthington 3" x 2", Worthite, #2CG2B, 75 GPM @ 139' 15 HP.
- 18—Worthington 2" x 1 1/2", Worthite, #1 1/2 CG1A, 5 HP.
- 81—Worthington 2" x 1 1/2", Worthite, #1 1/2 CG1A, 3 HP.
- 30—Worthington 2" x 1 1/2", Worthite, #1 1/2 CG1.
- 27—LaBour 2" x 1 1/2", T316SS, size #15, type DPL, self-priming, 3 HP.
- 3—Worthington 1 1/2" x 1", Worthite.
- 8—Ing.-Rand 10" x 8", Iron, size #8AFV, 1800 GPM.
- 50—Misc. Iron cent. & gear pumps.

**BOILERS**

- 3—3000 CFM Edgemoor waste-heat boilers, 250 psi, 535 sq. ft., ASME.
- 5—435 HP Comb. Eng. water-tube boilers, 300 psi, 4620 sq. ft., 34, 500 lb. steam/hr. @ 225% of rating, gas or oil fired.

**MISCELLANEOUS**

- 3—Alloy Fab. gas mixer-filters, (3) compartments, Stainless Steel contact parts.
- 30,000'—Stainless Steel pipe; 6", 4", 3", 2", 1 1/2", etc.
- 10,000'—Stainless Steel vapor pipe; 12", 16", etc.
- 10,000—Valves, Stainless Steel, all sizes.
- 18—Screens, Stainless, 33"x53", single deck.
- 18—Toledo platform dial scales, 200#.

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CIRCLE M ON READER SERVICE CARD



## RECENT PURCHASES

- 1—Glasco 2000 gal. blue glass-lined jacketed reactor, ASME 50 psi or vacuum int., 90 psi jkt.
- 6—30" OD x 19' high T304 SS packed columns, dished heads, 40 psi TP.
- 1—Standard Steel 6'-6" x 60' rotary dryer, 5/16" welded shell, lifters, etc.
- 2—2700 gal. T304 SS tanks, 7'-6" x 7'-6", 5/16" dished bottom, coils, Agit.
- 5—2100 gal. T304 SS tanks, 8' x 5'-6", 5/16" dished bottom, coils, Agit.
- 2—Bird 24" x 38" contin. centrifugals, T304 SS conical bowl, 25 HP.
- 1—Allis-Chalmers 5' x 5' ball mill, 75 HP.
- 1—Buřlovak 42" x 120" Dbl. Drum Dryer.
- 1—Raymond 50", 5-roller hi-side mill.
- 1—Gemco 60 cu. ft. T304 SS blender.
- 5—Nash SH-6 SS vacuum pumps.

## DRYERS—KILNS

- 5—Buřlovak 42" x 120" double drum dryers, ASME 160# WP.
- 1—American 42" x 120" dbl. drum, ASME, St. St. Acc.
- 1—Buřlovak 42" x 90" Dbl. drum.
- 1—Buřlovak 32" x 72" twin drum dryer, chrome plated drums, St. St. trim.
- 2—American 36" x 84" Dbl. Drum.
- 1—Buřlovak 32" x 52" dbl. drum.
- 1—American 36" x 84" double drum dryer, ASME, VACUUM.
- 1—Buřlovak 5' x 12', single drum dryer, Vacuum UNUSED.
- 5—F. J. Stokes #138J-16, 195 sq. ft. vac. chelf dryers.
- 1—Buřlovak 110 sq. ft. vac. shelf.
- 1—Turbulaire Stainless spray dryer.
- 1—Nerco-Niro stainless spray dryer.
- 1—Vulcan 10' x 11' x 175' rotary kiln.
- 2—10' x 78' rot. dryers, 3/4".
- 2—Hardinge 8'-8" x 70" rotary, 3/4".
- 1—Traylor 8' x 80' rotary, 3/4".
- 2—Davenport 8' x 60' rotary, 7/16" welded burners, fans, etc.
- 2—8' x 56' rot. kilns, 1/2" welded.
- 1—7'6" x 62' rotary kiln, 1/2".
- 1—Louisville 4'-6" x 25' steam-tube.
- 1—Bartlett & Snow 3' x 15' rotary dryer, Everdur metal shell.

## PRESSES

- 3—Komarek-Greaves 160,000 psi briquette presses.
- 4—Davenport dewatering presses; #1A, 2A, 3A.
- 1—French Oil #2-S extraction press.
- 2—Stokes #DDS-2 rotary tablet presses.
- 1—Stokes #T single-punch tab. press.
- 1—Stokes #RD-3 rotary tablet press.
- 1—HPM 63 ton steeping press, UNUSED.

# PERRY FOR PROCESS EQUIPMENT

## EVAP.—STILLS

### COLUMNS—CONDENSERS

- 7—4050 sq. ft. calandra type evap., copper tubes, cast iron shell.
- 1—Mojonnier 2085 sq. ft. triple-effect Stainless Sanitary evaporator.
- 4—Buřlovak double-effect stainless evap. vert. long-tube type: 1025, 840, 710, 588 sq. ft.
- 1—Stokes 118 sq. ft. T316SS Still.
- 1—Bartlett & Snow 6' dia. Stainless jkt. evap.-crystallizing kettle.
- 1—Vulcan 110" dia. x 16' high T316SS bubble-cap column, 10 trays.
- 1—Vulcan 60" dia. x 16' high, T316SS bubble-cap column, 10 trays.
- 1—36" dia. x 9'-8" T316SS bubble col.
- 15—Copper bubble-cap columns, 24" to 54" dia., to 51' high.
- 1—1960 sq. ft. T316SS exchanger, remov. bundle, ASME 75# WP.
- 1—1450 sq. ft. T316SS condenser.
- 5—1400 sq. ft. T316SS gas converters.
- 3—800 sq. ft. T316SS condensers.
- 1—730 sq. ft. T316SS exchanger.
- 1—510 sq. ft. T316SS condenser.
- 30—T316SS condensers & exchangers: 427, 425, 410, 400, 290, 277, 264, 250, 200, 185, 165, 150, 145, 105, 83, 73, 54, 52, 50, 47, 30 sq. ft.
- 12—185 sq. ft. T304SS U-tube coolers.

## MIXERS—MILLS

- 40—Baker-Perkins #17, 200 gal. sigma-blade, jkt. mixers.
- 1—Baker-Perkins #16-UUEM, 150 gal. Disp. blade, jkt., 150 HP, vaulted cover, motorized tilt.
- 1—Baker-Perkins #15, 100 gal. Disp., T347SS, 25 HP drive.
- 1—Baker-Perkins #15-UUEM, 100 gal., Disp. blade, ASME jkt., 100 HP, Comp. Cover, motorized tilt.
- 1—J. H. Day #6, 100 gal., St. St. sigma.
- 2—J. H. Day #5, 75 gal., sigma.
- 1—Raymond 66", 6-roller mill, 200 HP.
- 1—Raymond 50", 5-roller hi-side mill.
- 1—Allis-Chalmers 5' x 5' ball mill.
- 13—Abbe 6' x 8' batch pebble mills.
- 2—Hardinge 7' x 36" conical mills.
- 1—Babcock & Wilcox #E-32 mill, 75 HP.
- 1—Gemco 60 cu. ft. T304SS conical blender.
- 1—Mikro #2TH pulverizers, 10 HP.

## KETTLES—REACTORS

- 1—2000 gal. Glasco blue G/L reactor, ASME 50 psi or vac. int., 90 psi jkt.
- 1—1800 gal. T316SS reactor, vacuum internal, new jacket, Agit.
- 4—1350 gal. T347SS Kettles, open top, paddle agitators.
- 1—1000 gal. Dopp cast iron Kettle, 125# jacket, 15# int., Agit.
- 1—750 gal. Graver T304SS jkt. fermenter, ASME 30# int., 30# jkt., 10 HP Turbine Agit.
- 1—600 gal. Bartlett & Snow SS evap. & crystallizing jkt. Kettle.
- 21—600 gal. T304SS reactors, Jkt., Agit.
- 2—500 gal. T304SS reactors, jacketed, ASME, Vacuum—UNUSED.
- 6—465 gal. T304LSS reactors, jacketed, 150# int., 175# Jkt.
- 1—300 gal. Pfaudler blue G/L reactor, Agit., Jkt., ASME.
- 1—300 gal. Glasco blue G/L reactor.
- 1—200 gal., T304SS, vac. int., 200# WP Jkt., Agit.

## FILTERS—CENTRIFUGALS

- 6—Shriver 48" C.I. P&F filter presses, 1000 sq. ft., closed delivery.
- 6—Valley 36" aluminum P&F filter presses, 65 ch., closed delivery.
- 5—Sweetland #12 filters, (72) stainless
- 1—Niagara #510-28, T316SS filter.
- 1—Oliver 5'3"x8' recast rotary vacuum filter, UNUSED.
- 2—Oliver 5'3"x3' precoat rot. vac. filter, T316SS, ASME 30# WP.
- 1—48" Tolhurst susp. cent., T304SS.
- 5—40" A.T.&M. susp. cent., T304SS.
- 2—32" A.T.&M. susp. cent., T304SS.
- 1—12" A.T.&M. susp. cent., T304SS.
- 26—Sharples #A5-16V super cent., Inconel, vapor-tite, sludge-disch. frame.
- 2—Sharples #16-P super cent., T304SS.
- 2—Sharples #C-20 Super-D-Hydrators.
- 1—Bird 24" x 38" cylin. Steel.
- 2—Bird 24" x 38", T304SS, cylind.
- 3—Bird 24" x 24" Slotted, Monel

## STAINLESS STEEL TANKS

300—STAINLESS STEEL TANKS IN STOCK—Sizes up to 13,000 gal.—T304, 316, 321, 347, etc.—many with Coil & Agitators.

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CIRCLE N ON READER SERVICE CARD



# ECONOMIZE DOLLARWISE

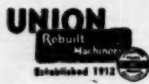
- 1—Merco CX 16 Centrifuge type 316 stainless steel. 60 HP Mtr
- 5—Sweetland #12 Filters 2 lvs on 2" Centers. Deep bottoms. Auto motor driven sluicing
- 1—60" Dorco Clariflocculator Thickener Mech. Complete
- 3—Lawrence type 316 vert 3" Submerged Pumps. 250 GPM @100'

- 6—Rotary Flame Dryers: 5x40', 6x35', 6x50' and 6x60'. Comp.
- 1—Bullovak Vac Oven. 6 tray 22"x22" Complete with vac Pump and Motor
- 2—Tolhurst 48" dia susp stain. perfi bask Centrifuges. Mtrs
- 1—Roots Connersville 22"x54" type RCDH. 11,900 CFM @ 28 oz



**MACHINERY AND EQUIPMENT CO., INC.**  
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## MODERN REBUILT MACHINERY



Baker Perkins, Day, W & P Heavy Duty Mixers, 5 to 150 gal. caps.  
Colton models 241 and 260 Double Rotary late style Tablet Presses.  
J. H. Day Dry Powder Mixers, 50 to 1000 lbs.  
Rotex, Day Sifters 20 x 48, 20 x 80, 40 x 120.  
WRAPPERS: Package Machinery, Hayssen, Hudson Sharp, Battle Creek, Scandia, Wrap-King, all sizes and models.  
Pneumatic Scale High Speed Automatic Cartoning Line with Feeder, Bottom Sealer, Top Sealer, Wax Liner, Interconnecting conveyors.  
Stokes & Smith Models G1, G2, HQ84, HQ87 and HQ88 Auger Powder Fillers.  
Colton 6' diam. Stainless Steel Revolving Pan.  
Fletcher 30" Stainless Steel Basket Centrifuge.  
Raymond Model "O" Pulverizer.  
Mikro 2DH Stainless Steel Pulverizer.  
Mikro No. 6 S.S. Atomizer and Bantam, 15H, 2TH, 3TH, and 4TH Pulverizers.  
Flitzpatrick KB Stainless Steel Comminuter.

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9 Gen. Elec. 20, 25, 45, 65, 70, 80, 100, 125 Ton  
25-Ton Industrial Brownhoist 60' Boom Crane  
200—50 Ton Box 300—70 Ton Gondola Cars  
300—1½, 5, 20 & 30 yd Dump Cars

### PLANT EQUIPMENT

4' Traylor TY Gyrostat Crusher  
2—Wemco 2M-HMS Plants  
No. 1 Stertevant Rotary Fine Reduction Crusher  
F55 Syntex Grizzly Feeder  
5' x 9' & 4½' x 9' KVS Air Swept Ball Type Mills  
Ball Mills: No. 36, 5' x 5', 6' x 4', 6' x 9' & 7' x 22'  
Hardinge Mills: 3 x 8', 3' x 24' & 5' x 22'  
Rod Mills: 4' x 11', 6' x 12' & 7' x 15'  
Jaw Crushers: 8' x 10", 9' x 24", 10' x 30",  
12' x 26", 13' x 24", 14' x 28", 18' x 36", 30' x  
36", 48' x 60", 60' x 84"  
Crushers, Fine Reduction: 22", 2', 3', 4', 8½' & 7'  
136 Allis Chalmers 75 H.P. Motor  
Crushers Roll: 24" x 14", 30" x 14", 40" x 16"  
Rotary Dryers: 5' x 30', 8' x 50', 6' x 70' & 8' x 80'  
Rotary Kilns: 6' x 70', 7' x 120' & 9' x 160'  
2—42" x 120" Bullovak Atmos. Double Drum Dryer  
Roto Louvre #207-10 Type 316 S.S. Link Belt  
150—1½, 2 & 4 yd & 30 yd Dump Cars  
7'x120' Allis Chalmers Rotary Kiln ½" welded shell  
3' x 12' Bee Single Deck Vibrating Screen  
160' Gayco Centrifugal Air Separator  
BX-100 Sutton Steele & Steele Air Table NEW  
6—30" x 32" Dings Magnetic Head Pulleys  
600', 2200', 3600' & 3600-7500' IR. Compressors  
4100 CFM Silty Dust Collector

WANT BUY DRYERS—KILNS—CRUSHERS  
R. C. Stanhope, Inc., 60 E. 42 St., N.Y. 17, N.Y.  
Tel. MU 2-3075 or MU 2-1898

### CIRCLE Q ON READER SERVICE CARD

### CIRCLE O ON READER SERVICE CARD

## SPECIALS

Kettles: 69 Lee 40 gal. stain. clad, 40# WP.  
Concentrator: Deister 5x8' rubber covered.  
Columns: 24" x 22", 316 stain. steel.  
Pebble Mills: Abbe #3, #5, and others.  
Dryer: American 24x48" dbl. drum.  
Dryer: Bowen lab. spray, st. st.  
Evaporator: Bullovak sgl. eff. st. st. 94 sq. ft.  
Dryer: Porter 2 x 4' vac. drum., st. st.  
Centrifugal: Tolhurst 26" rubber, 2-speed.  
Filter: Sweetland #25 st. lined.  
Filter: Eimco, drum 18" x 12".  
Vacuum Pans: 42" and 72" stain. steel.  
Dryer: Proctor & Schwartz 6-tray st. st.  
Centrifugal: AT & M 60" st. part.

Write us or call Sealey & 1431  
Send us a list of your idle machines  
**LOEB EQUIPMENT SUPPLY CO.**  
820 W. Superior St., Chicago 22, Ill.

### CIRCLE R ON READER SERVICE CARD

## EXCELLENT VALUES!

1—Autoclave 1000 gal—30 Gal. S.S.  
1—Kent 13" x 32" 12x48" 3 Roll Mill.  
3—Day 40 Gallon Pony Mixers.  
1—Charlotte S.S. Colloid Mill, ND20.  
2—Sparkler S.S. Filters 5-3 & 14-4.  
1—Hercules 8" & 16" Type 316 S.S. Filters  
1—Day Stainless Steel Blender 2000 #  
3—Day Size "C" & "F" Spiral Blenders.  
1—Raymond 30" Double Whizzer Separator  
3—Worthite S.S. Pumps 1½" x 1" to 8" x 6"  
4—Rotex Screens 20" x 48"—30" x 96" to 60" x 84".  
2—Cycloterm Pack Boilers 18 & 30 H.P.  
1—S.S. Green Jack. Kettle 100 Gal. w/Agitator.  
1—Resina Model Spec. Automatic Capper.

We Buy Your Surplus. Send Us Your Inquiries.

The Machinery & Equipment Co., Used Div.

## HARING EQUIPMENT CORP.

Newark 5, N. J. Market 2-3109

### CIRCLE S ON READER SERVICE CARD

## BEST VALUES

Evaporator: Bullovak dbl. eff. st. st. 845 sq. ft.  
Evaporator: Bullovak dbl. eff. st. st. 608 sq. ft.  
Evaporator: Mojonier dbl. eff. st. st. 1250 sq. ft.  
Evaporator: Bullovak sgl. eff. st. st. 67 sq. ft.  
Evaporator: Swenson four eff. C.I. 5700 sq. ft.  
Dryers: Double Drum, 42 x 96; 32 x 100 Bullovak.  
Dryer: Double Drum, 42 x 120 American.  
Dryer: Rotary Steam Tube, Louisville 6' x 25' (2).  
Vetator—Girdler, with 2—4' x 46" S.S. T316. chill.  
ing cylinders.  
Centrifuges Tolhurst 40" and 26" Suspended, perfi.  
Centrifuges: Bird continuous, 18 x 28, S.S. T316.  
Filter: Rotary Vacuum with pressure housing, Door  
Oliver 5.3" dia. x 4" face (2).  
Tanks: 2300 (2)—1500 gal. Vertical St.St.  
Tanks: 3000 (2)—1500—300 gal. vertical St.St. for  
vacuum, with coils.  
Kettles: (2) 500 gal. agitated st. st.: with 15 P.S.I.  
steel jacket.

BEST EQUIPMENT COMPANY  
1737 W. HOWARD ST. CHICAGO 26, ILL.  
A.M.B.A. 2-1452.

### CIRCLE T ON READER SERVICE CARD

## WANTED—Autoclave and FILTER

Autoclave must be minimum 30" dia., prefer up to  
90" dia. Filter must have minimum 50 feet filter  
area, prefer up to 120 ft., must be aluminum or  
SS, platen frame type, maximum frame thickness  
1".

W-6861, Chemical Engineering  
Class Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

### CIRCLE U ON READER SERVICE CARD

NEW FILTER, stainless steel NIAGARA  
48" dia. w/510 sq. ft.

NEW GRANULATOR #24, Stokes oscil-  
lating, S/S, also used 43A, S/S

NEW VOTATOR, S/S, lab. model, 4 speed  
FURNACE, electric, 5"x12"x30"  
muffle, 1600°C, Globe, w/50KVA  
transformer

MIKRO PULVERIZERS, 2 model 2TH w/  
10HP motors & vari-drive feeds

OVEN, Truck/Tray, 650° F. electric,  
5'X6'X14", self-contained package  
unit.

## LAWLER COMPANY

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### CIRCLE V ON READER SERVICE CARD

Dowtherm 225 KW  
Autoclave S.S.—50 gal—2000 lb. pres.  
Autoclave S.S.—3½ gal—2000 lb. pres.  
Proctor & Schwartz flamed drum drier  
Centrifuge S.S. 26"—Tolhurst  
2 Evaporating Dishes—Jacketed S.S. 71"  
dia.  
1 Kettle S.S.—Jacketed—500 gal.  
2 Kettles S.S. Jacketed—agitated—250  
gal.

## MACHINECRAFT CORPORATION

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TURBO-GENERATORS • DIESELS  
PUMPS • FANS • BURNERS • HEATERS

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EXPERIENCED ENGINEERS TO ASSIST YOU



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PHONE IN 3-0303  
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CHICAGO 45, ILL.

### CIRCLE X ON READER SERVICE CARD

## ECH SPECIAL

Abbe Eng. Jacketed 5' x 6' Ball Mill.  
chrome manganese steel. Price \$2750.00.

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EQUIPMENT CLEARING HOUSE, INC.  
111 33 Street Brooklyn 32, N. Y.

### CIRCLE Y ON READER SERVICE CARD

Hersey 5'x26' Rotary S.S. Dryer  
Buffalo 32"x90" Double Drum Dryer  
Day Hy-R Speed Mill 20 HP XP

SEND FOR LISTINGS  
STEIN EQUIPMENT CO.  
107—8th Street Sterling 8-1944 Brooklyn 15, N. Y.

### CIRCLE Z ON READER SERVICE CARD

## Ion Exchange Plant For Sale.

Complete Fully Automatic Ion Exchange Plant,  
capable of treating 90,000 gallons per day contain-  
ing 3.75 grams per litre U<sub>2</sub>O<sub>5</sub>. Surplus due to  
completion of government contract. Used two  
years, condition excellent. Any offer considered.

RAYROCK MINES LIMITED  
Discovery, N.W.T. Canada

### CIRCLE AA ON READER SERVICE CARD

# It's HIGH time to enjoy the extras in **GELB** **CHEMICAL PROCESS EQUIPMENT**

- 1—Niagara type 316 SS horiz. filter, Model 136H-245-3
- 1—Pfaudler Model XL 1000 gal. glass lined jacketed reactor
- 2—International SS horiz. jacketed double ribbon blenders, 40 cu. ft., complete with motors.
- 1—AT&M SS 40" link suspended centrifuge with perforate basket and explosion proof motor.

## AUTO. KETTLES, REACTORS

- 2—Pfaudler Series EM 300 gal. glass lined jacketed reactors
- 1—Pfaudler 750 gal. glass lined reactor, jacketed
- 4—Pfaudler Series P glass lined jacketed reactors, complete with agitators and drives, 5, 20 and 30 gal.
- 2—Theo. Walters, Hastelloy B, 300 gal. jacketed reactors
- 2—Blaw Knox 200 gal. jacketed autoclaves, nickel, 175 psi jacket and internal
- 1—Blaw Knox 300 gal. stainless steel vacuum reactor
- 2—Blaw Knox steel autoclaves, 600 gals.
- 1—Alloy Fabricators steel jacketed autoclave, 600 gals.
- 1—Van Alst 300 gal. stainless steel jacketed kettle
- 2—Process Equipment 10,000 gal. SS vertical tanks, NEW
- 1—10,000 gal. horizontal rubber lined storage tank
- 3—Glascote 500 gal. glass lined vacuum receivers

## DRYERS

- 2—Bonnot rotary kilns, 8' x 115', complete
- 1—Bonnot rotary cooler, 8' x 50', complete
- 1—Allis Chalmers stainless steel rotary dryer, 8' x 50'
- 10—Allis Chalmers rotary dryers, 6' x 50' and 7' x 60'
- 1—Bullovak SS jacketed rotary vacuum dryer, 5' x 30'
- 1—Link Belt steel roto louver dryer, Model 207-10
- 1—Link Belt steel roto louver dryer, Model 502-20
- 2—Stokes SS jacketed rotary vacuum dryers, 3' x 15' and 2' x 6'
- 1—American 42" x 120" double drum dryer, ASME, complete
- 1—Bullovak steel jacketed rotary dryer, 3' x 15'
- 2—Stainless steel pilot plant spray dryers
- 1—Stokes single door vacuum shelf dryers, 6 shelves

## CENTRIFUGES

- 1—AT&M 48" SS suspended type centrifuge, complete
- 1—Fletcher 48" SS underdriven centrifuge, complete
- 1—AT&M 26" type 316 SS suspended type centrifuge, complete
- 3—Tolhurst 40" and 30" rubber covered centrifuges
- 1—Sharples type 316 SS Super-D-Canter, PN-14, complete
- 1—Sharples type 316 SS centrifuge, Model D-2
- 1—Sharples C-20 Super-D-Hydrator, monel

## FILTERS

- 2—Oliver SS rotary filters, 3' x 2' and 3' x 4'
- 1—Hercules SS filter with 6 leaves



THE GELB GIRL—JUNE 1961

- 12—Sweetland #12 pressure leaf filters with 72 SS leaves
- 1—Niagara stainless steel filter, Model 510-28
- 1—Sperry 36" x 36" heresite covered filter press, 40 chambers
- 10—Shriver plate and frame filter presses, 12" to 42"

## MIXERS

- 1—Gemco type 316 SS jacketed conical rotary vacuum blender, 82 cu. ft.
- 1—Sturtevant #7 Dustite rotary batch blender, NEW
- 15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
- 1—Robinson type 304 SS horizontal blender, 125 cu. ft.
- 1—Baker Perkins 150 gal. dispersion mixer, complete
- 1—J. H. Day 5 gal. double arm sigma blade mixer, SS
- 1—Stokes stainless steel granulating mixer, Model 21-J

## MISCELLANEOUS

- 1—Cleaver Brooks 500 HP package steam generator, 200#
- 1—Cleaver Brooks 150 HP package steam generator, 150 psi
- 1—Superior 300 HP package steam generator, 125 psi
- 1—Sprout Waldron pelletizer, Type 501 FF
- 1—Williams "Comet" 4 roll mill, complete
- 1—Raymond 2 roll high side mill
- 1—6" x 14" Ross 3 roll paint mill, high speed, complete
- 1—Vulcan SS bubble cap column, 4' dia. x 25 plates
- 1—Griscom Russell SS heat exchanger, 900 sq. ft.
- 1—Downington SS heat exchanger, 750 sq. ft.
- 3—Badger SS heat exchangers, 500 sq. ft. and 600 sq. ft.
- 4—Patterson SS condensers, 200 and 300 sq. ft.
- 20—Davis Engineering SS heat exchangers, 102, 119, 136, 166 sq. ft., NEW
- 2—Davis Engineering Carpenter 20 heat exchangers, 120 sq. ft.
- 2—Mikro Bantam pulverizers
- 2—Mikro #3TH SS pulverizers, complete
- 3—Pfaudler glass lined thimble type condensers, 9 and 14 sq. ft.
- 1—Struthers Wells SS 1150 sq. ft. single effect evaporator

- 1—300 gal. Hastelloy "B" jacketed pressure reactor
- 4—Patterson Kelley SS twin shell blenders, 4 qt. and 2 cu. ft.
- 1—125 gal. SS jacketed autoclave with impeller type agitator and drive, 125 psi jacket, 75 psi internal
- 1—Banbury #1 mixer with 30 HP motor.



# R. GELB & SONS, INC.

U. S. HIGHWAY 22, UNION, N. J. MURDOCK 6-4900

75  
ANNIVERSARY

## What's News in Mixing?

by **COWLES**  
DISSOLVERS

**WORLD-WIDE,  
INDUSTRY-WIDE USERS SAY:  
"COWLES DISSOLVER® EQUIPMENT  
MAKES A BIG DIFFERENCE"**

If your processing requires dispersion, deagglomeration, mixing or dissolving, the comments of Cowles users all over the free world may point the way to substantial advantages for you. Here are a few of hundreds in our files from some 72 countries.—

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"... extraordinary good results with these pigments ... using our micronized Red Oxide obtained a reading of 8 3/4 on the P.C. (1-10) Scale in 10 minutes ... with our Leadchrome/Prussian Bluegreen obtained 8 1/4 in 3 minutes."

### GERMANY

"With the Cowles we obtain the best wetting out within shortest time. This makes it possible for us to save on mill passes. Because of this the machine has proven to be absolutely invaluable to us."

### ITALY

"... by using the Cowles as premixer we are saving 2 passes out of 3 on the 3-roller mill."

### DENMARK

"... Certain products which need roller milling when using traditional mixing methods, can now be produced directly on the Cowles, without roller milling."

### COLOMBIA

"Your equipment has provided us with such excellent results that we want immediately to obtain additional Cowles ..."

### SPAIN

"The Cowles Dissolver which we bought has given us magnificent results."

### JAPAN

"Your equipment works very satisfactorily ... It will give high production with the added advantage of easy cleaning and quick change-over."

The high-speed, high-shear principle of the "COWLES DISSOLVER" design, plus the unique transmission system that is capable of delivering over 90% of motor power to the patented impeller, can help you save money, time and space.

Let us prove it in your plant—at our risk!  
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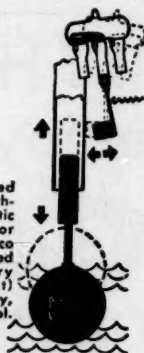
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## permanent magnetic force...



A sleeve, raised and lowered within a nonmagnetic tube, attracts or releases an Alnico magnet attached to the mercury (or dry contact) switch. Basically, this is Magnetrol.



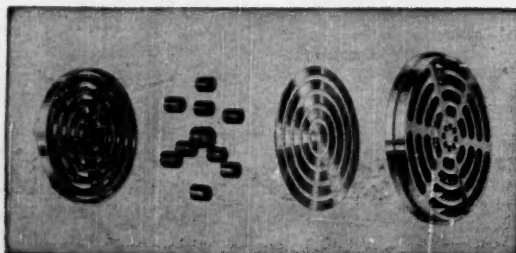
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**LIQUID LEVEL CONTROL**

Because its operating principle, based on the proper use of a permanent magnet, guarantees a perpetual guardianship over your critical liquid levels, the Magnetrol liquid level control unobtrusively takes the most important place in any system or process where it is necessary to keep a liquid at a constant level. Principle and action are so simple that failure is virtually impossible. Magnetrol is versatile, too—will handle almost ANY liquid, at ANY temperature, at ANY pressure, with the same precision and dependability. No mechanical or electrical linkages to stick, bind, ride out of line or wear out. Available for controlling level changes from 1/8" to 150 ft. Multi-stage switching when desired. Write to

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Voss Valves are made to specification, machined from solid stock (not cast)—using best alloy steels; for corrosion condition—stainless steels, such as 410, 18-8 or non-ferrous alloys—monel, inconel, etc. Plates are machined (not stamped) and ground for precise close tolerance fit; are dimensionally stable ... ductile ... resist fracture, high temperatures and corrosion ... withstand fatigue. Springs of heavy rectangular sections and large diameters add to dependability and safety.



- up to 40% more valve area
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- higher efficiency
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- quiet, vibration-free
- utmost safety
- lower operating costs

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proposal send name,  
bore, stroke and  
speed of machine.

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INCORPORATED

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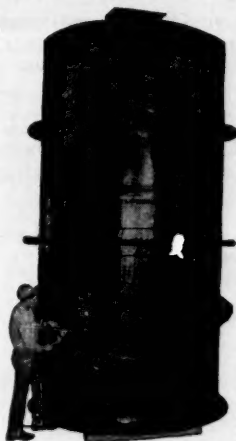
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...even the **LARGEST** corrosion problems are routine with *du Verre* reinforced plastic construction



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Large, *du Verre*-built process vessel measuring 10' I.D. x 21' high has precision-mounted baffles and internal fittings... requires no supporting braces, either internal or external, even if completely full of process liquid.

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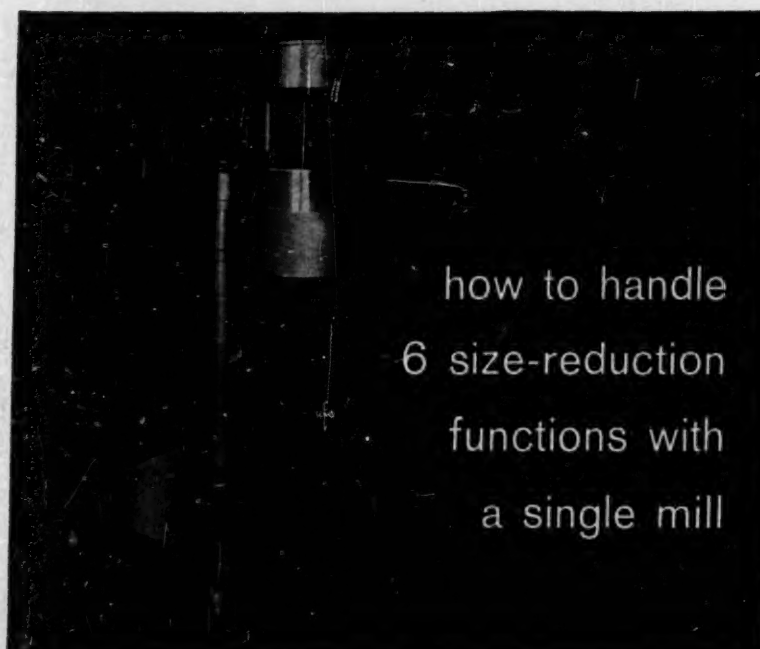
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Complete Corrosion Control  
with Reinforced Plastics

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how to handle  
6 size-reduction  
functions with  
a single mill

**Granulating, pulverizing, dispersing, dissolving, pulping and chopping** ... all 6 functions can be performed on the Stokes Tornado Mill at higher efficiencies and greater product yields than conventional mills. A look at the advanced design features of the Stokes Tornado Mill will tell you why:

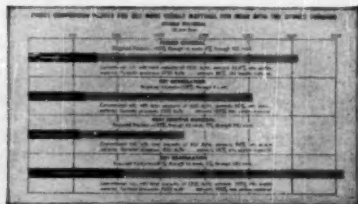
• **360° Screen.** This feature provides full working area with no "dead" spots. Products are expelled at the precise moment they reach the desired size. There's no overworking ... fines are reduced to a minimum ... for maximum product uniformity.

• **Versatility.** A wide variety of processing chemicals and other materials can be handled efficiently ... including wet, sticky and heat sensitive materials that other mills can't process without clogging or damaging the product.

• **Easier-To-Clean.** Entire working section can be cleaned and replaced in a matter of minutes, making it easy to switch from one product to another.

• **Portability.** Mounted on casters, the Tornado Mill goes where the work is ... gives greater utility and convenience.

• **Minimum Maintenance.** There are only two spare parts required. Sturdy construction throughout ensures smooth, vibration-free operation even at high speeds.



**WRITE FOR HANDY CHART** which shows by direct comparison that Stokes Tornado Mills produce more usable material per hour than conventional mills. The extra capacity you get with the Tornado can bring big savings to your milling operation. Write for your copy today.

**STOKES**

Size Reduction Equipment Division

**F. J. STOKES CORPORATION**, 5500 Tabor Road, Philadelphia 20, Pa.  
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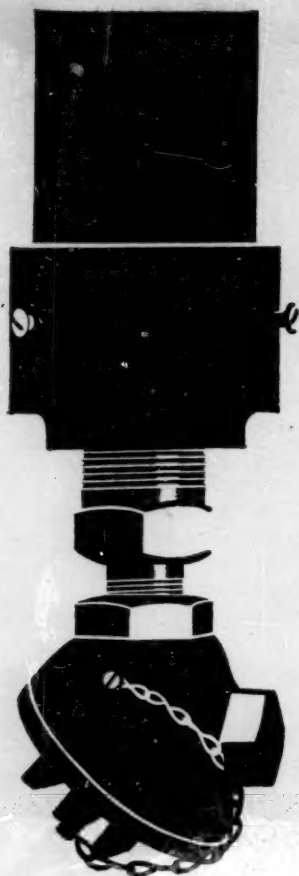


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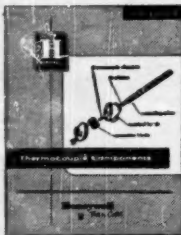
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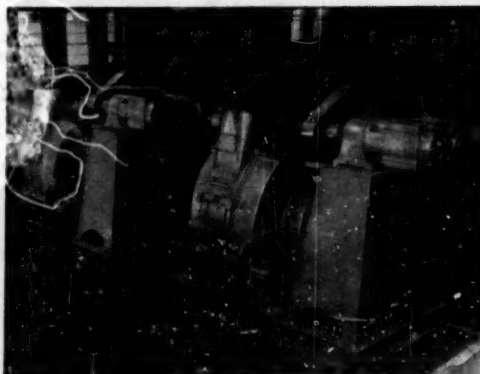
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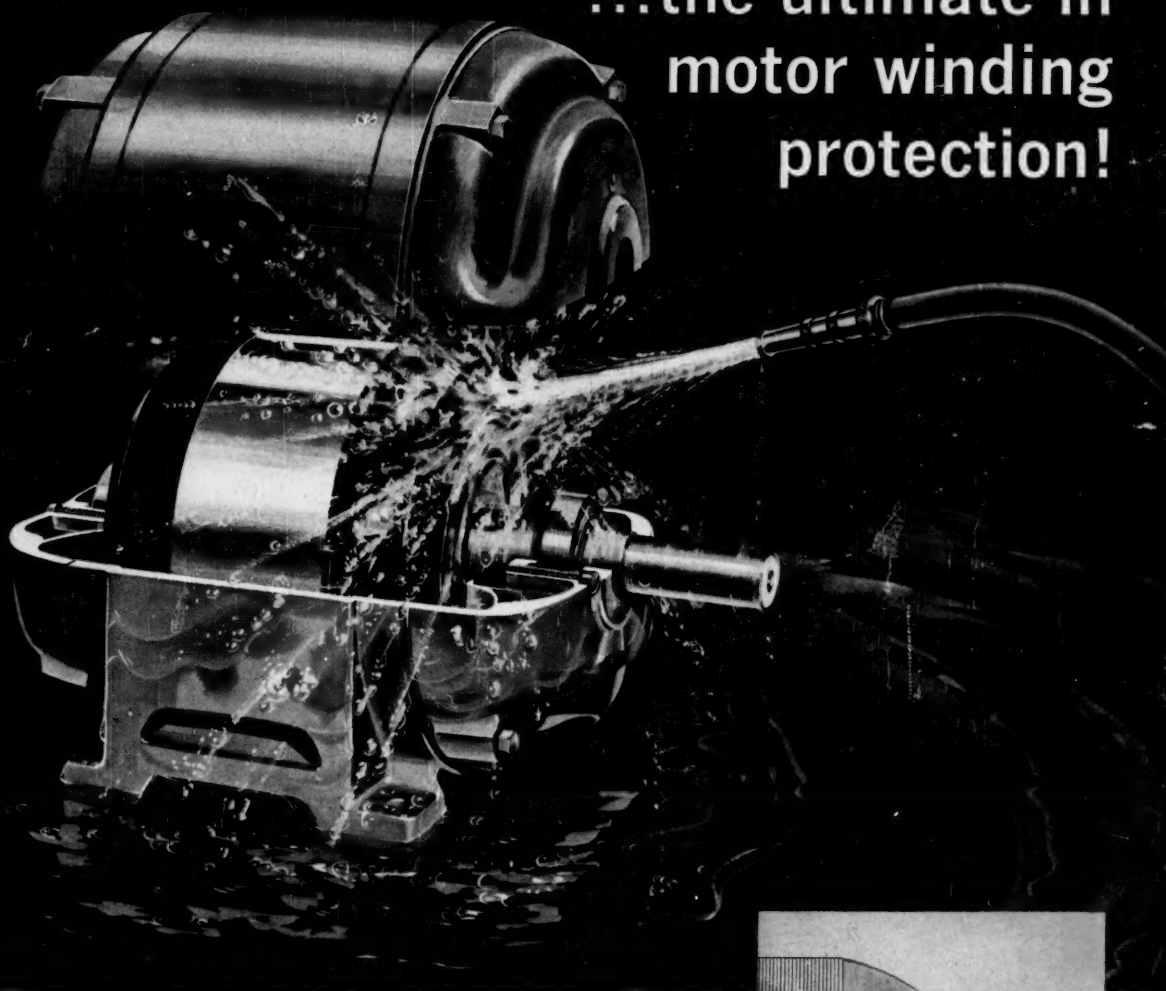
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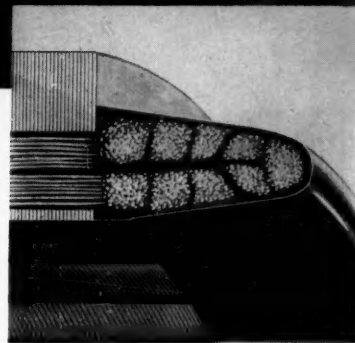
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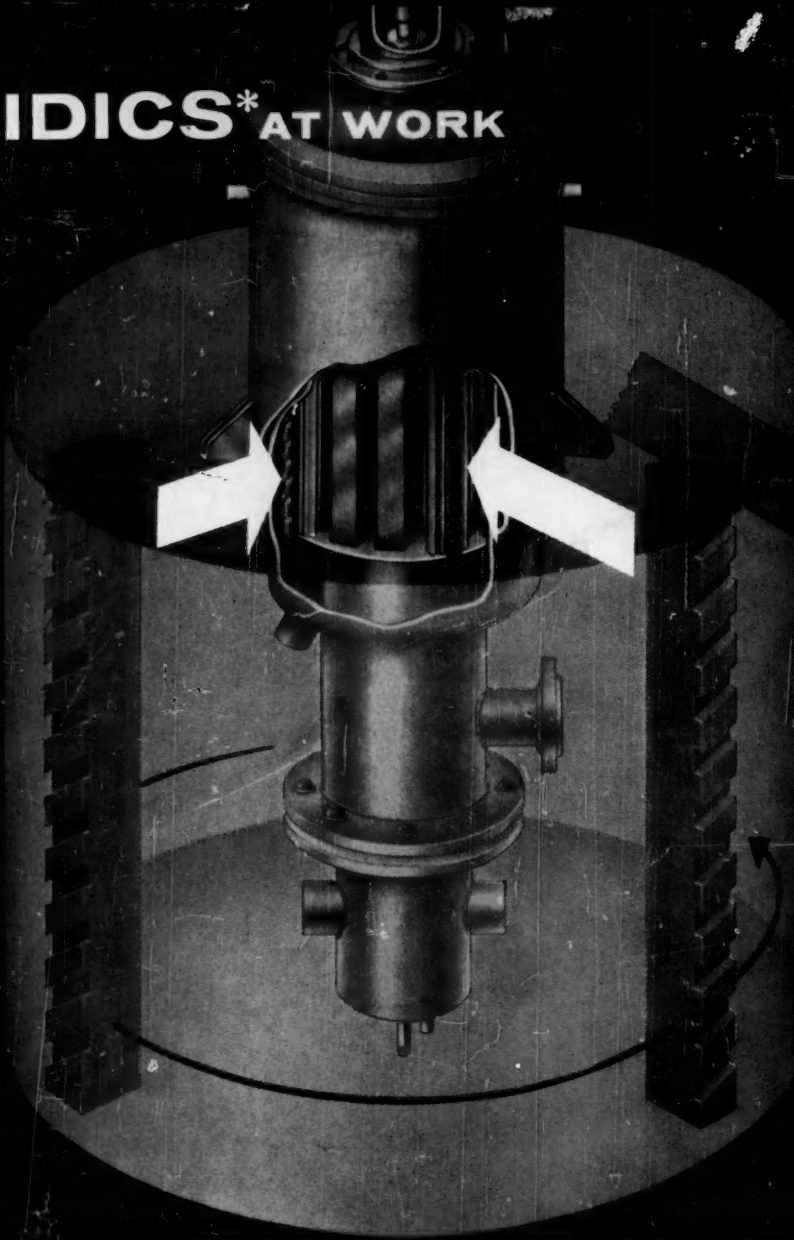
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